LOAN DOCUMENT

PHOTOGRAPH THIS SHEET

DTIC ACCESSION NUMBER

LEVEL

INVENTORY

O

SITE SPECIFIC TECHNICAL REPORT FOR SHORT-TERM PILOT TEST FOR...

DOCUMENT IDENTIFICATION

1 MAY 95

DISTRIBUTION STATEMENT A
Approved for Public Release
Distribution Unlimited

DISTRIBUTION STATEMENT

ACCESSION FOR

NTIS GRA&I ☑

DTIC TRAC ☐

UNANNOUNCED ☐

JUSTIFICATION

BY

DISTRIBUTION/

AVAILABILITY CODES

DISTRIBUTION	AVAILABILITY AND/OR SPECIAL	
A-1		

DISTRIBUTION STAMP

DATE ACCESSIONED

DATE RETURNED

20001215 091

DATE RECEIVED IN DTIC

REGISTERED OR CERTIFIED NUMBER

PHOTOGRAPH THIS SHEET AND RETURN TO DTIC-FDAC

HANDLE WITH CARE

DTIC FORM 70A JUN 90

DOCUMENT PROCESSING SHEET

PREVIOUS EDITIONS MAY BE USED UNTIL STOCK IS EXHAUSTED.

LOAN DOCUMENT

DRAFT

SITE-SPECIFIC TECHNICAL REPORT

for

SHORT-TERM PILOT TEST FOR THE BIOSLURPING FIELD INITIATIVE AT TRAVIS AFB, FAIRFIELD, CALIFORNIA

by

J.A. Kittel, L.A. Smith, M.C. Place, D.C. Foor, and E. Drescher

for

MR. PATRICK HAAS
AIR FORCE CENTER FOR ENVIRONMENTAL EXCELLENCE
BROOKS AFB, TEXAS 78235

May 1, 1995

BATTELLE
505 King Avenue
Columbus, Ohio 43201-2693

Contract No. F41624-94-C-8012

DEFENSE TECHNICAL INFORMATION CENTER
REQUEST FOR SCIENTIFIC AND TECHNICAL REPORTS

Title AFCEE Collection

1. Report Availability *(Please check one box)*

☒ This report is available. *Complete sections 2a - 2f.*

☐ This report is not available. *Complete section 3.*

2a. Number of Copies Forwarded 1 each

2b. Forwarding Date July/2000

2c. Distribution Statement *(Please check ONE box)*

DoD Directive 5230.24, "Distribution Statements on Technical Documents." 18 Mar 87, contains seven distribution statements, as described briefly below. Technical documents MUST be assigned a distribution statement.

☒ DISTRIBUTION STATEMENT A: Approved for public release. Distribution is unlimited.

☐ DISTRIBUTION STATEMENT B: Distribution authorized to U.S. Government Agencies only.

☐ DISTRIBUTION STATEMENT C: Distribution authorized to U.S. Government Agencies and their contractors.

☐ DISTRIBUTION STATEMENT D: Distribution authorized to U.S. Department of Defense (DoD) and U.S DoD contractors only.

☐ DISTRIBUTION STATEMENT E: Distribution authorized to U.S. Department of Defense (DoD) components only.

☐ DISTRIBUTION STATEMENT F: Further dissemination only as directed by the controlling DoD office indicated below or by higher authority.

☐ DISTRIBUTION STATEMENT X: Distribution authorized to U.S. Government agencies and private individuals or enterprises eligible to obtain export-controlled technical data in accordance with DoD Directive 5230.25, Withholding of Unclassified Technical Data from Public Disclosure, 6 Nov 84.

2d. Reason For the Above Distribution Statement *(in accordance with DoD Directive 5230.24)*

2e. Controlling Office HQ AFCEE

2f. Date of Distribution Statement Determination 15 Nov 2000

3. This report is NOT forwarded for the following reasons. *(Please check appropriate box)*

☐ It was previously forwarded to DTIC on _____ *(date)* and the AD number is _____

☐ It will be published at a later date. Enter approximate date if known. _____

☐ In accordance with the provisions of DoD Directive 3200.12, the requested document is not supplied because:

_____

_____

_____

Print or Type Name	Signature
Laura Peña	Laura Peña
Telephone 210-536-1431	*(For DTIC Use Only)* AQ Number M01-03-0535

TABLE OF CONTENTS

List of Figures

List of Tables

EXECUTIVE SUMMARY

This report summarizes the field activities conducted at Travis AFB (TAFB), CA, Area G or Jet Fuel Storage Area 1 (JFSA-1) for a short-term field pilot test of vacuum-enhanced free-product recovery (bioslurping) in comparison to traditional free product techniques. The field testing at TAFB is part of the Bioslurping Field Initiative which is funded and managed by the U.S. Air Force Center for Environmental Excellence (AFCEE). The AFCEE Bioslurper Initiative is a multisite program designed to evaluate the efficacy of bioslurping technology for (1) the recovery of light, nonaqueous-phase liquid (LNAPL) from groundwater and the capillary fringe; and (2) enhancing natural in situ degradation of petroleum contaminants in the vadose zone via bioventing.

The main objective of the Bioslurping Field Initiative is to develop procedures for evaluating the potential for recovering free-phase LNAPL present at petroleum-contaminated sites. The overall study is designed to evaluate bioslurping and to identify site parameters that are reliable predictors of bioslurping performance. To allow measurement of LNAPL recovery in a wide variety of in situ conditions, tests are being performed at many sites. The test at TAFB is one of at least 35 similar field tests to be conducted at various locations throughout the United States and its possessions.

The intent of field testing is to collect data to support a determination of the predictability of LNAPL recovery, and to evaluate the applicability, cost, and performance of the bioslurping technology for removal of free product and remediation of the contaminated area. The testing is structured to allow direct comparison of the LNAPL recovery achieved by bioslurping with the performance of more conventional LNAPL recovery technologies. The test method in this study included an initial evaluation of site variables followed by LNAPL recovery testing. The specific test objectives, methods, and results for the TAFB test program are discussed in the following sections. The three technologies used at TAFB to recover the free LNAPL floating on the water table were skimmer pumping, vacuum-enhanced pumping (bioslurping) at the oil/water interface, bioslurping at 18 in. below the oil/water interface, and drawdown pumping at both 18 in. and 30 in. below the oil/water interface.

Site characterization activities were conducted to evaluate site variables that could affect the efficiency of LNAPL recovery and to determine the bioventing potential of the site. Testing included soil sampling, slug testing, in situ respiration testing, and baildown testing.

Following the site characterization activities, the actual pilot tests for the skimmer pumping, bioslurping, and drawdown pumping were conducted. The bioslurper system was installed in an

existing extraction well, well #5303. The pilot test sequence was as follows: 1 day in the skimmer mode (no vacuum); 1 day in bioslurping (vacuum-mediated) mode at the oil/water interface; 4 days in the bioslurper mode with the drop tube at 18 in. below the interface; 1 day in the drawdown mode (groundwater depression mode) with the drop tube at 18 in. below the interface; and 2 days in the drawdown mode with the drop tube at 30 in. below the oil/water interface. Free product was not collected during the skimmer-mode test and the bioslurper test with the drop tube at the oil/water interface because heavy rains before and during the pilot test changed the level of the water table. The water table needed to be lowered before any free product could be recovered. Therefore, the drop tube was placed 18 in. below the water table for the bioslurper test. Measurements of the extracted soil gas composition, free product thickness, and groundwater level were made throughout the testing. The volumes of LNAPL recovered and groundwater extracted were quantified over time.

At the TAFB site, only the bioslurping and drawdown recovery configurations were able to recover LNAPL from well #5303. The rates of recovery for the first day of bioslurping (18 in. below oil/water interface) and drawdown (18 in. and 30 in. below oil/water interface) modes of operation were 6.78 gal/day, 3.25 gal/day, and 3.38 gal/day, respectively. The rate of recovery for the bioslurper decreased over time to 3.85 gal/day, but was still greater than the recovery rate for either of the drawdown modes of operation. The skimmer pump test was unable to recover any LNAPL from well #5303. Clearly, LNAPL recovery was significantly enhanced by the application of the bioslurper/vacuum-enhanced recovery technology.

Furthermore, the vacuum-enhanced pilot test also demonstrated the ability of the technology to increase oxygen concentrations in the vadose zone to over the undisturbed oxygen-limited conditions.

Implementation of bioslurping at the TAFB test site will likely facilitate enhanced recovery of LNAPL from the water table and should also initiate simultaneous in situ biodegradation of hydrocarbons in the vadose zone via low-flow vapor extraction (bioventing). The expanded and extended testing planned for TAFB will examine the aspects of long-term viability for the bioslurping technology at this site.

DRAFT

SITE-SPECIFIC TECHNICAL REPORT

for

SHORT-TERM PILOT TEST FOR THE BIOSLURPING FIELD INITIATIVE AT TRAVIS AFB, FAIRFIELD, CALIFORNIA

May 1, 1995

1.0 INTRODUCTION

This report describes the activities performed and data collected during a field test of vacuum-enhanced pumping (bioslurping) at Travis Air Force Base (TAFB), California. The field testing at TAFB is part of the Bioslurping Field Initiative, which is funded and managed by the U.S. Air Force Center for Environmental Excellence (AFCEE). The AFCEE Bioslurper Initiative is a multi-site program designed to evaluate the efficiency of bioslurping technology for (1) recovery of light, nonaqueous-phase liquid (LNAPL) from groundwater and the capillary fringe and (2) enhancing natural in situ degradation of petroleum contaminants in the vadose zone via bioventing.

1.1 Objectives

The main objective of the Bioslurping Field Initiative is to develop procedures for evaluating the potential for recovering free-phase LNAPL present at petroleum-contaminated sites. The overall study is designed to evaluate the efficiency of bioslurping and to identify site parameters that are reliable predictors of bioslurping performance. To allow measurement of LNAPL recovery in a wide variety of in situ conditions, tests are being performed at many sites. The test at TAFB is one of at least 35 similar field tests to be conducted at various locations throughout the United States and its possessions. Aspects of the testing program that apply to all sites are described in the *Test Plan and Technical Protocol for Bioslurping* (Battelle, 1995). Test provisions specific to activities at TAFB are described in a site-specific test plan.

The intent of field testing is to collect data to support determination of the predictability of recovery of LNAPL, and to evaluate the applicability, cost, and performance of the bioslurping

technology for removal of free product and remediation of the contaminated area. The onsite testing is structured to allow direct comparison of the LNAPL recovery achieved by bioslurping with more conventional LNAPL recovery technologies. The test method included an initial evaluation of site variables followed by LNAPL recovery testing. The specific test objectives, methods, and results for the TAFB test program are discussed in the following sections. The three technologies used at Travis AFB to recover the free LNAPL floating on the water table were skimmer pumping, vacuum-enhanced pumping (bioslurping) at the oil/water interface and 18 in. below the oil/water interface, and drawdown pumping at 18 in. and 30 in. below the oil/water interface.

1.2 Testing Approach

Initial site characterization activities were conducted to evaluate site variables that could affect LNAPL recovery efficiency and to determine the bioventing potential of the site. These activities included soil sampling to determine physical/chemical site characteristics, slug tests to evaluate the hydrogeologic conditions near the test well, and in situ respiration testing to evaluate site microbial activity.

Following the site characterization activities, the actual pilot tests for the skimmer pumping, bioslurping (vacuum-enhanced pumping), and drawdown pumping were conducted. The bioslurper system was installed so that an existing groundwater extraction well, well #5303, could be used for the testing. The LNAPL recovery testing was conducted in the following sequence: 1 day in the skimmer mode at the oil/water contact (no vacuum); 1 day in the bioslurper mode (vacuum-mediated mode) at the oil/water interface; 4 days in the bioslurper mode 18 in. below the oil/water interface; and 3 days in the drawdown mode (groundwater depression mode), including 1 day with the drop tube 18 in. below the oil/water interface and 2 days with the drop tube 30 in. below the interface. In general, the tests were run immediately one after another in sequence. Measurements of the extracted soil gas composition, free product thickness, and groundwater level were made throughout the testing. The volume of LNAPL recovered and groundwater extracted were quantified over time.

2.0 SITE DESCRIPTION

Figure 1 displays the location of the main features within the area used for the pilot testing. Well #5303 is located in the northeast corner of the fuel storage area. A diagram of the general arrangement of the extraction well and soil gas monitoring points is shown in Figure 2. Site

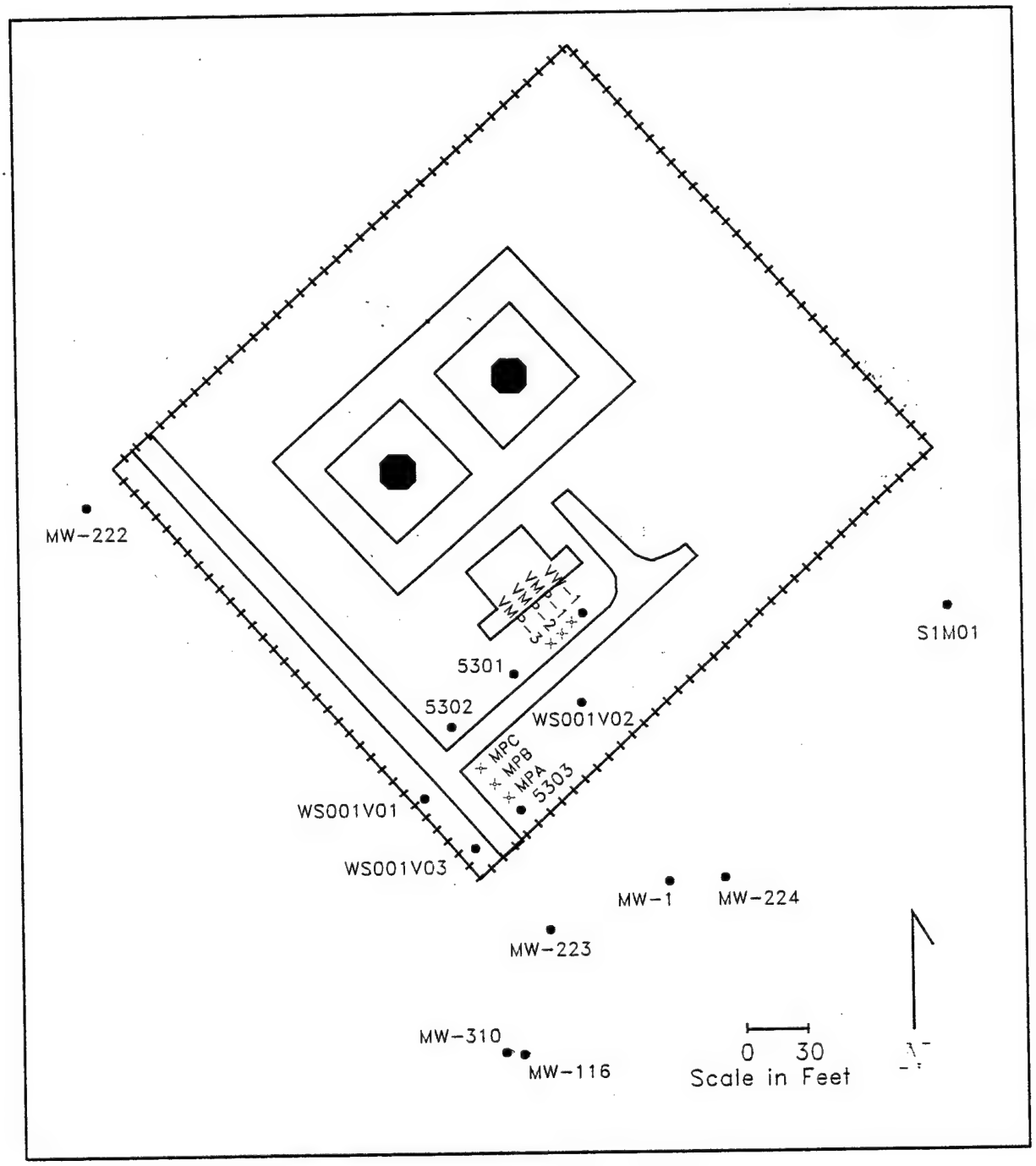


Figure 1. Location and Arrangement of Bioslurper Test Site on Travis Air Force Base

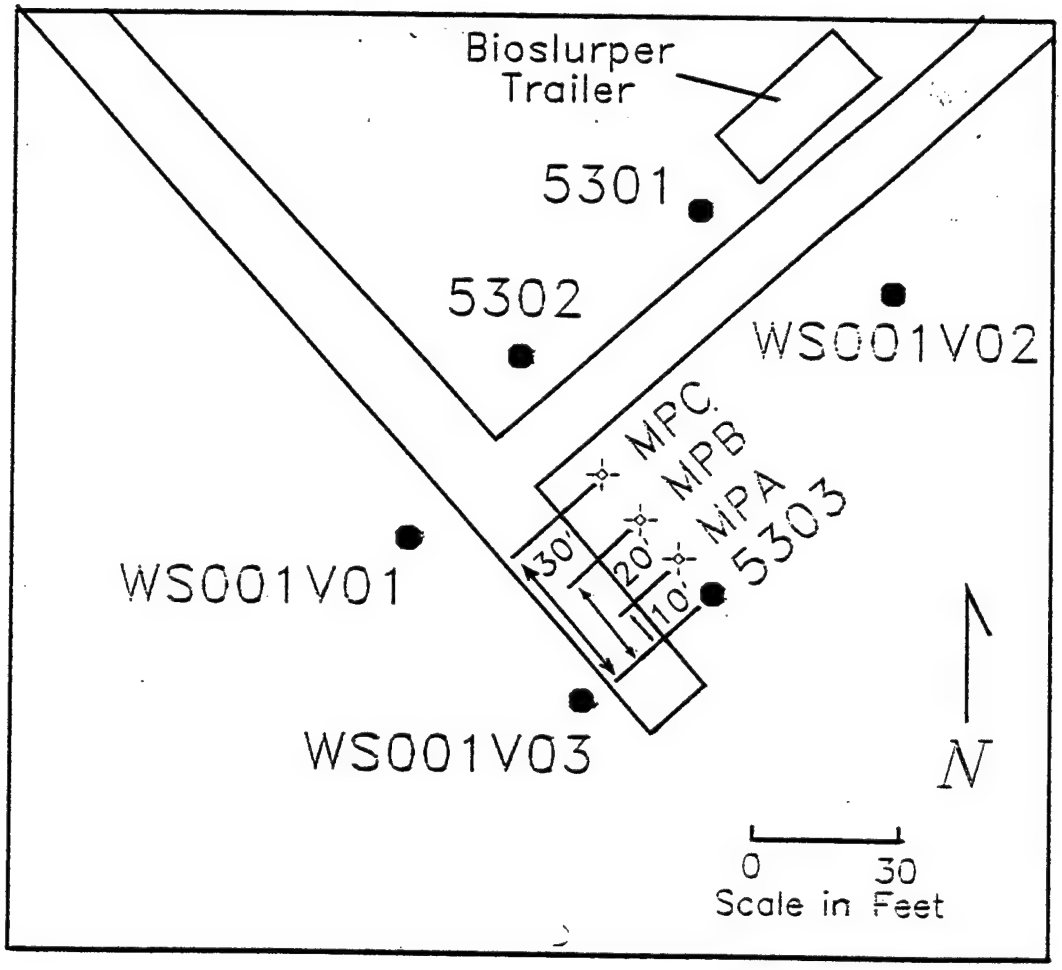


Figure 2. General Arrangement of Bioslurper Monitoring Points and Equipment at the Test Site

personnel indicate that a JP-4 fuel spill near the center of JFSA-1 is the most likely source of contamination in the area. Previous characterization of the site reported that the thickness of free product within the test area ranged from 0.2 to 2.0 ft during one sampling event. In addition, soil-gas total petroleum hydrocarbons (TPH) and benzene concentrations in the pilot test area ranged from 30 to 940 ppm and 0.7 to 11 ppm, respectively.

Groundwater extracted at TAFB cannot be directly discharged to the base sanitary sewer system or storm sewer system. It first must be analyzed for contamination from benzene, toluene, ethylbenzene and xylenes (BTEX) and for TPH contamination before it can be discarded. To conduct the pilot tests, an arrangement was made with the base point of contact (PoC) to hold the extracted groundwater until it could be disposed of properly to the TAFB industrial waste treatment facility. A 21,000-gal holding tank located within JFSA-1 was used to hold groundwater extracted during the short-term pilot testing. Base personnel made all the arrangements for disposal of the groundwater. Vapor discharge was limited to 165 lb of TPH/day. Due to the relatively low concentration of TPH compounds in the off-gas and the relatively low air-flow rate, the discharge levels remained below the regulated limit.

3.0 BIOSLURPER SHORT-TERM PILOT TEST METHODS

This section describes the test equipment and methods used for the short-term pilot test at TAFB and documents the initial conditions at the test site.

3.1 Initial LNAPL/Groundwater Measurements and Baildown Testing

Well #5303 was selected for installation of the test equipment because it had the thickest layer of free product and historically had the greatest LNAPL recovery. Potential initial LNAPL thickness measurements and depth to groundwater were completed using an oil/water interface probe (ORS Model# 1068013). A typical baildown test was not completed on the wells because a free-product recovery system was still operating when the Battelle staff members arrived at the site.

3.2 Monitoring Point and Thermocouple Installation

On January 11 and 12, 1995, three monitoring points were installed in the area of extraction well #5303. The monitoring points (MPs) were labeled MPA, MPB, and MPC. A cross section of the monitoring points showing the site's lithology and well installation detail is displayed in Figure 3.

A soil gas sample collection probe, connected to ¼-in. tubing, was used to establish each sampling level in a monitoring point. The soil gas probe was 1 inch in diameter and had a 6-in. screened interval to sample soil gas. The probe was positioned at the appropriate depth, and then the annular space corresponding to the screened length of the soil gas sample collection probe was filled with silica sand. The interval between the screened lengths was filled with bentonite clay chips, as was the space from the top of the shallowest monitoring point up to ground surface. The bentonite clay was hydrated with water after placement to expand the chips and develop a seal. The soil gas probes in the monitoring points were installed at the following depths as shown in Figure 3:

- MPA was installed 10 ft south of well #5303 and drilled to a depth of 9.5 ft with a borehole diameter of approximately 4 inches. Sampling points were placed at three depths in the borehole with the bottom of the sampling screens at 3.0, 5.5, and 8.0 ft.

- MPB was installed 20 ft south of well #5303 and drilled to a depth of 9.0 ft with a borehole diameter of approximately 4 inches. Sampling points were placed at three depths in the borehole with the bottom of the sampling screens at 3.0, 5.5, and 8.0 ft.

- MPC was installed 30 ft south of well #5303 and drilled to a depth of 10.0 ft with a borehole diameter of approximately 4 inches. Sampling points were placed at three depths in the borehole with the bottom of the sampling screens at 2.0, 5.5, and 8.0 ft.

Type K thermocouples were installed in MPA at depths of 3.0 and 8.0 feet.

3.3 Soil Sampling and Analyses

Four soil samples were collected during the installation of the monitoring points. Approximately 400 g of soil was collected at the capillary fringe (7.0 to 7.5 ft) from monitoring points MPA and MPC. The samples were collected using a hand-driven sampler with a 6-in. brass sleeve. The soil samples were labeled as follows: JFSA-1-MPA-1 (7-7.5 ft), JFSA-1-MPC-1 (7-7.5

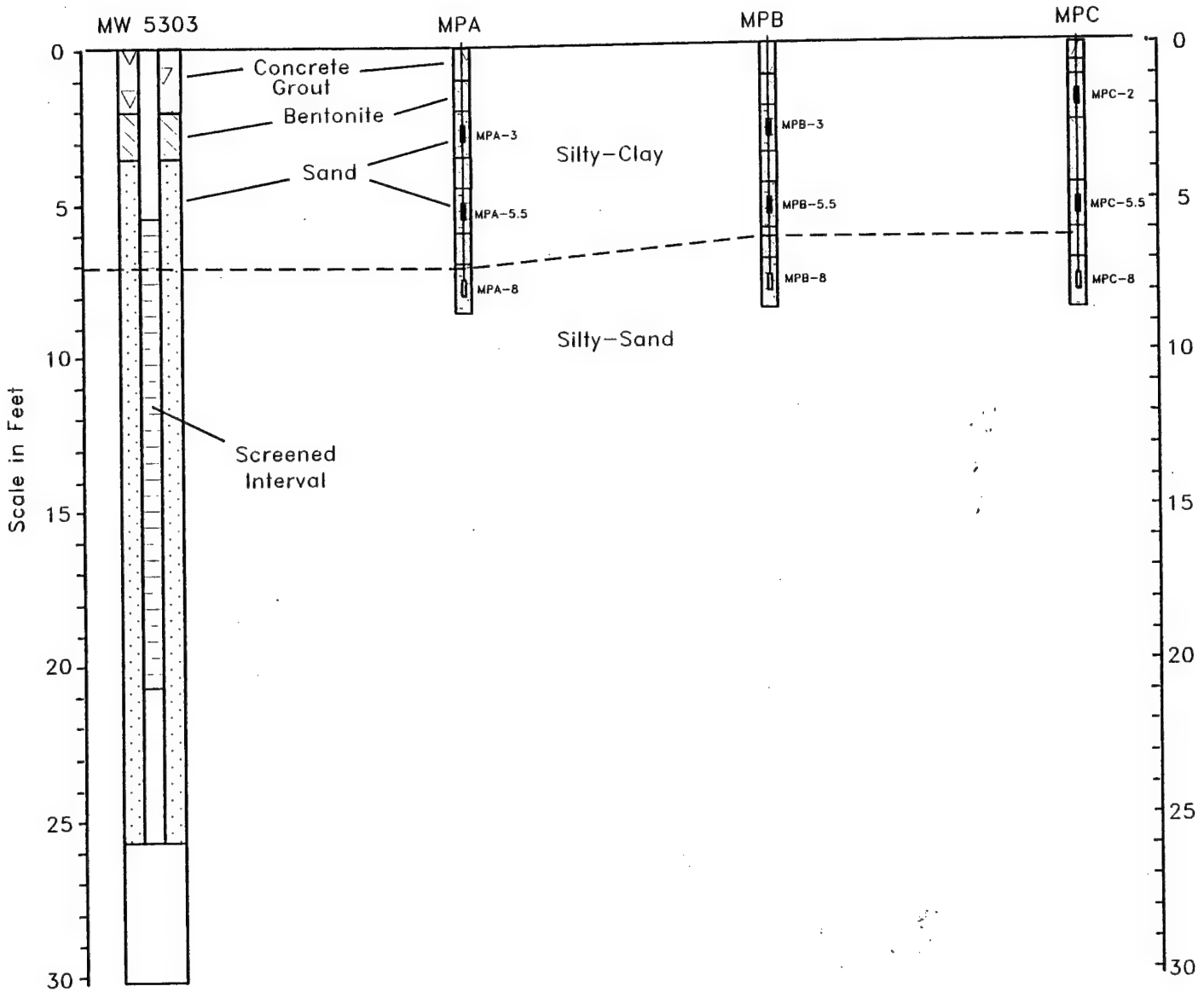


Figure 3. Bioslurper Short-Term Pilot Test Monitoring Point Installation Detail

ft), JFSA-1-MPC-2 (7.5-8 ft), and JFSA-1-MPC-3 (8-8.5 ft). The samples were placed in insulated coolers containing "blue ice." Chain-of-custody records and shipping papers were completed, and the samples were sent to Alpha Analytical, Inc. in Sparks, Nevada by overnight air express. The samples were analyzed for BTEX; TPH; alkalinity; pH; moisture content; total Kjeldahl nitrogen; total phosphorous and total iron; density; porosity; and grain size distribution.

3.4 Soil Gas Sampling and Analyses

After installation of the monitoring points, initial soil gas measurements were taken with a GasTech brand O_2/CO_2 meter and a GasTech brand TraceTechtor hydrocarbon meter. The initial soil gas compositions are shown in Table 1.

TABLE 1. INITIAL SOIL GAS COMPOSITIONS AT TRAVIS AIR FORCE BASE IN JFSA-1

Monitoring Point	Depth (ft)	Oxygen (%)	Carbon Dioxide (%)	TPH (ppm)
MPA	3.0	4.0	9.0	>20,000
	5.5	0.0	11.0	>20,000
	8.0	3.0	10.0	>20,000
MPB	3.0	2.0	10.0	>20,000
	5.5	0.0	11.0	>20,000
	8.0	0.0	12.0	>20,000
MPC	2.5	6.0	8.0	>20,000
	5.5	0.0	12.0	>20,000
	8.0	4.0	10.0	>20,000

3.5 System Shakedown

The bioslurping pilot test system is a trailer-mounted mobile unit. The vacuum pump, oil/water separator, and required support equipment were carried to the test location on the trailer. The trailer was located near well #5303.

The well cap on well #5303 was replaced with a compression-type seal with a hole so that the drop tube could be lowered into the well. The drop tube was attached to the vacuum pump.

Different configurations of the compression seal and the placement depth for the dip tube allow operation in the bioslurping mode, simulations of skimmer pumping, or drawdown pumping as described in Sections 3.7, 3.6, and 3.9, respectively.

A brief startup test of the system was performed prior to the LNAPL recovery testing to ensure that all the system components were working properly. The system checklist is shown in Appendix A. All site data and information for the field testing were recorded in a field notebook and then transcribed onto the pilot test data sheets shown in Appendix B.

3.6 Skimmer Simulation Recovery Test

On January 12, 1995, the skimmer simulation recovery test was started. The oil/water interface was first measured with the oil/water interface probe. The initial conditions for the skimmer test are shown in Table 2.

TABLE 2. INITIAL CONDITIONS IN WELL #5303 FOR THE SHORT-TERM BIOSLURPER TEST

Test end date, Time

Test	Test Start Date, time	Fuel Depth (ft)	Water Depth (ft)	Fuel Thickness (ft)
Skimmer Pump Test	January 12, 1995	8.30	8.70	0.40
Bioslurper Test	January 14, 1995	8.16	8.20	0.04
Drawdown Pump Tests	January 23, 1994	8.16	8.20	0.04

15 hrs

27 hrs

The pump used for the skimmer test was an Atlantic Fluidics Model A100, which is a 7.5-hp liquid ring pump. A diagram showing the configuration of the well and slurper tube for the skimmer simulation recovery test is shown in Figure 4. For the skimmer simulation recovery test the extraction tube was set at the LNAPL/groundwater interface with the wellhead open to the atmosphere at the compression seal. Prior to the start of the test, the liquid ring pump and the oil/water separator (OWS) were primed with groundwater, to ensure that any LNAPL or groundwater entering the system could be quantified. The flow totalizers for the LNAPL and aqueous effluent were zeroed and the liquid ring pump was then started to begin the skimmer test. The test was operated continuously for 44.5 h. The LNAPL and groundwater extraction rates were monitored throughout the test, as were all other relevant data for the skimmer simulation recovery test.

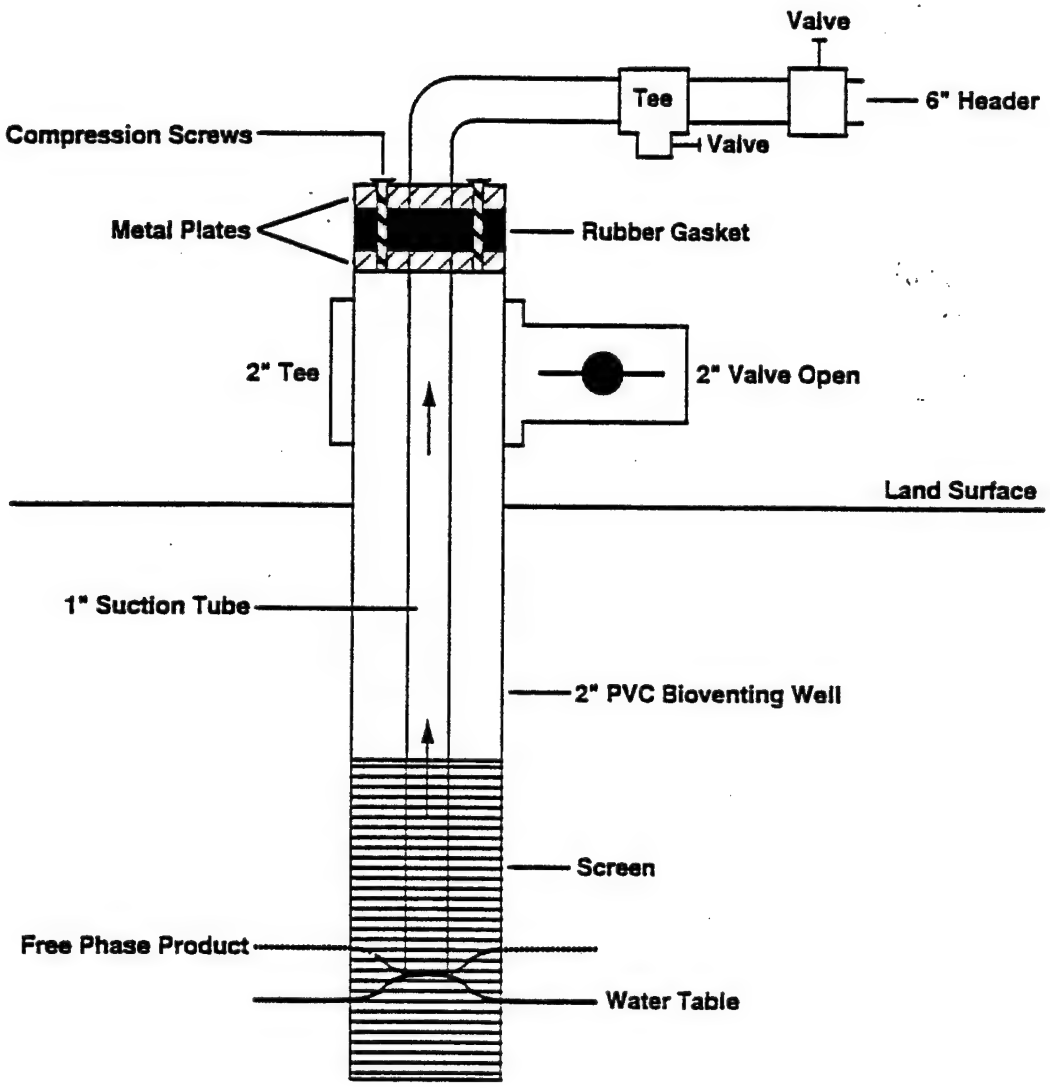


Figure 4. Slurper Tube Placement for the Skimmer Simulation Recovery Test

3.7 Bioslurper (Vacuum-Enhanced) Recovery Test

Upon the completion of the skimmer simulation recovery test, preparations were made to begin the vacuum-enhanced (bioslurper) recovery test. Approximately 15 hours passed between the shutdown of the skimmer test and the start of the bioslurper test. First, the oil/water interface in extraction well #5303 was measured again. The initial fluid levels in well #5303 are shown in Table 2. The extraction tube was again placed at the LNAPL/groundwater interface just as it was in the skimmer pump test. However, the vents in the compression seal were closed to allow the vacuum pump to establish a vacuum in the well. A pressure gauge was installed at the wellhead to measure the vacuum inside the extraction well. The same pump used for the initial bioslurper test was an Atlantic Fluidics A100 (7.5 hp). The configuration of the well and slurper tube for the vacuum-enhanced pump test is shown in Figure 5. For this test all product and groundwater flow totalizers were zeroed and reset, so that the groundwater extraction and LNAPL recovery rates could be quantified accurately. The liquid ring pump was then started to begin the bioslurper pump test. The test was started on January 14, 1995 and operated continuously for 15.5 hours. The LNAPL and groundwater extraction rates were monitored throughout the test, as were all other relevant data for the bioslurper pump test.

Due to the lack of free-product recovery during the first 15 hours of vacuum-mediated extraction, the drop tube was lowered to a depth of 18 in. below the oil/water interface measured on January 15, 1995. The configuration of the rest of the system remained unchanged between the bioslurper tests with the drop pipe at the oil/water interface and 18 in. below it. This second vacuum-enhanced test was started on January 17, 1995. During the second vacuum-mediated test, pump problems resulted in the shutdown of the system for 21 hrs between January 18, 1995 and January 19, 1995. On January 19, the system was restarted using an Atlantic Fluidics Model A100 liquid ring pump (3.5 hp). Again, all other components of the system remained the same and method of data collection was unchanged.

3.8 Soil Gas Permeability Testing

The air permeability test data were collected during the vacuum-enhanced pumping (bioslurping) operation. Prior to establishing a vacuum in the extraction well, the initial soil gas pressures from the three monitoring points were recorded. The start of the bioslurping test created a pressure drop in the extraction well which was the starting point for the soil gas permeability testing.

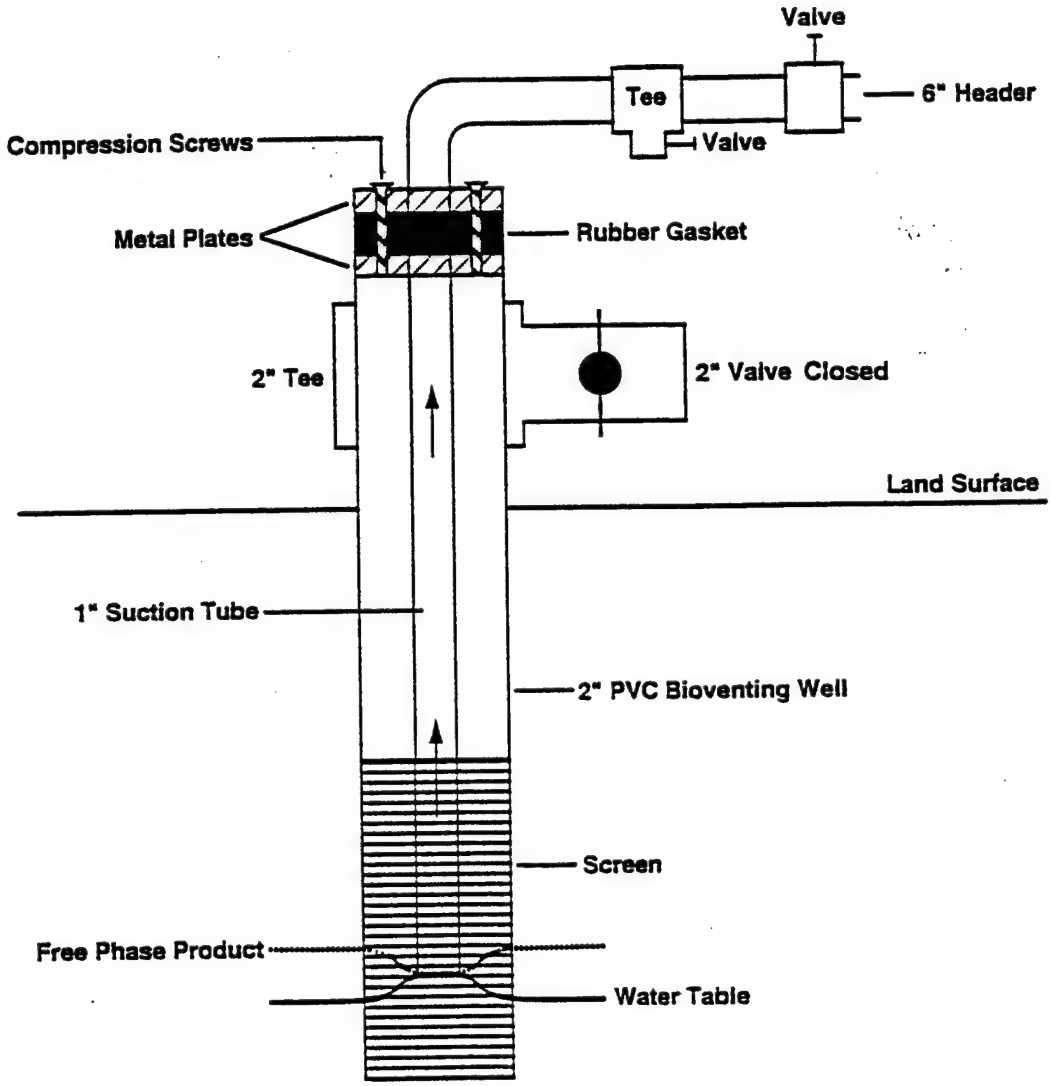


Figure 5. Slurper Tube Placement for the Bioslurper (Vacuum-Enhanced) Recovery Test

Soil gas pressures were measured in each of the three monitoring points at all depths to track the rate of outward propagation of the pressure drop from the extraction well. Soil gas pressure data were collected frequently during the first 60 minutes of the test. After the first 60 minutes, the data were collected less frequently, because of the rate of the pressure change. The soil gas pressures were recorded throughout the bioslurper pump test to determine the bioventing radius of influence.

3.9 Drawdown Pump Test

After the 4 days of testing in the bioslurper pump mode with the drop tube at 18 in. below the oil/water interface, the test was stopped and preparations were made for the drawdown pump test. The vents on the compression seal were again opened so that the well was open to the atmosphere. Approximately 27 hours passed between the end of the vacuum-enhanced test and the start of the first drawdown test. The drop tube was left at 18 in. below the oil/water interface for the first 24 hours of this test and then was lowered to 30 in. below the interface measured on January 15, or 10.7 ft below ground surface (bgs) for the remaining 24 hours of the test. This tube placement creates a cone of depression in the water table around the extraction well and induces LNAPL flow toward the extraction well. A diagram showing the general configuration of the drawdown pump test is depicted in Figure 6. Initial conditions for the drawdown pump test are shown in Table 2. The drawdown test with the drop tube at 9.7 ft bgs was run for 12 hours, and the drawdown test with the drop tube at 10.7 ft bgs was run for 24 hours. Before each of the drawdown tests, the LNAPL and groundwater flow totalizers were reset to determine the efficiency of the product recovery with the bioslurper in the drawdown mode. The LNAPL recovery rate and groundwater extraction rate were quantified over time.

3.10 In Situ Respiration Testing

Air containing approximately 1% helium was injected into three of the monitoring points for approximately 24 hours, beginning on January 22, 1995. The setup for the in situ respiration test is described in the *Bioventing Test Plan and Technical Protocol* (Hinchee et al., 1992). The pump used for the air and helium injection was a ½-hp diaphragm pump. Air and helium were injected through the following monitoring points: MPA-5.5 ft, MPB-8.0 ft, and MPC-5.0 ft. After the air/helium injection was ceased, the respiration gases were monitored periodically. The respiration test was terminated on January 26, 1994.

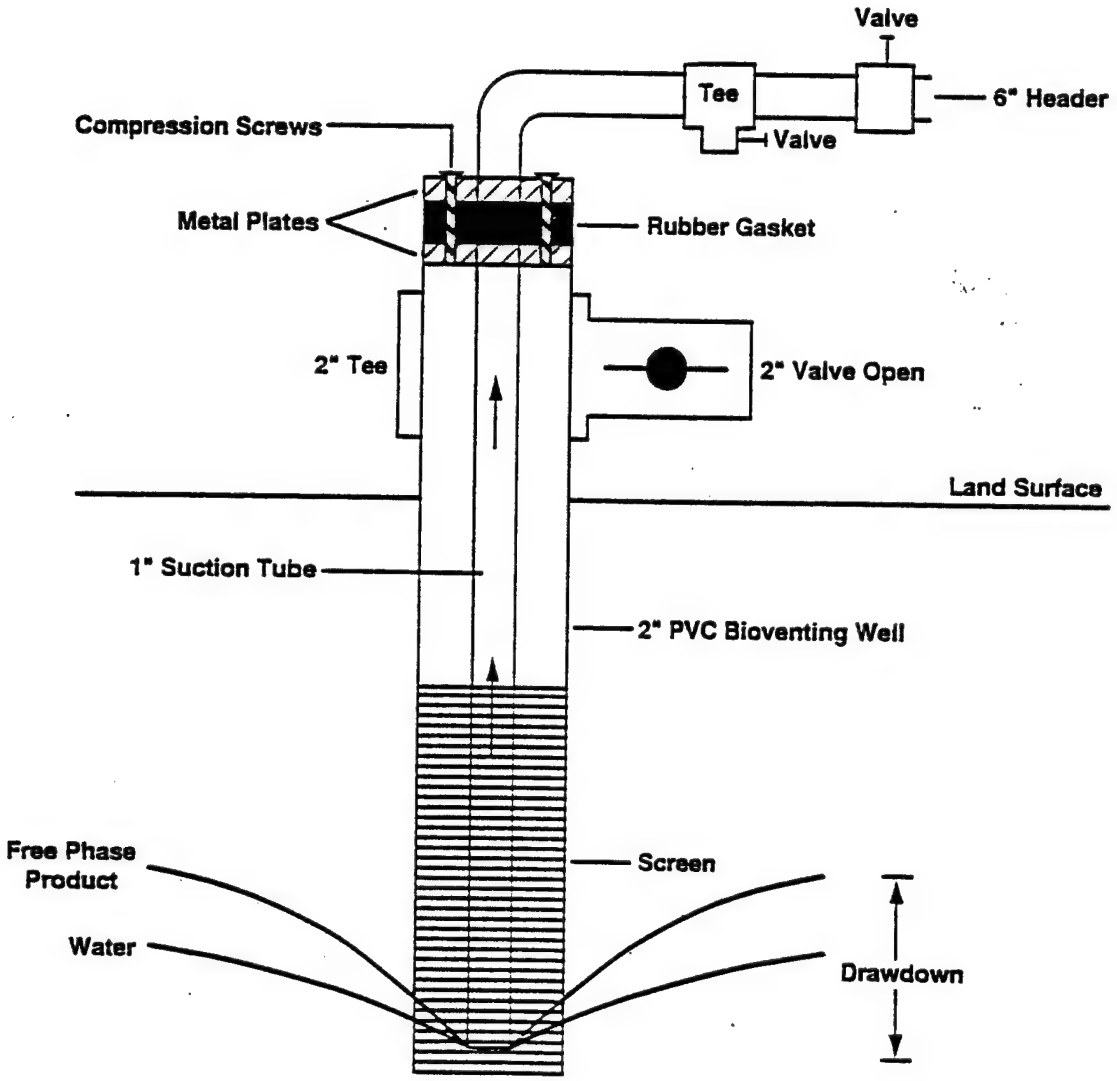


Figure 6. Slurper Tube Placement for the Drawdown Simulation Recovery Test

Helium concentrations were measured during the in situ respiration test to quantify soil gas movement around the monitoring points. Any helium loss over time is directly attributable to either diffusion through the soil or leakage. If a rapid drop in helium concentration is observed it is usually an indication of leakage through the monitoring point. A gradual loss of helium over time indicates gas transport by diffusion. When the oxygen concentration decreases faster than the helium concentration, the loss of oxygen is attributed to biological degradation of hydrocarbons (unless the soil chemical oxygen demand is unusually high). The decrease in oxygen concentration can be used to determine the biodegradation rate in terms of mg as a hexane equivalent per kg of soil per day.

3.11 Slug Testing

The slug tests were performed at the short-term pilot test area on January 22, 1995. Slug testing was performed in the extraction well used for the pilot testing, well #5303. The results of the slug tests help quantify the hydrogeologic properties of the formation near the test well. The slug tests were done by creating an instantaneous change in head within the well using a PVC slug. The instruments used to record the data produced during the slug test were a pressure transducer (Model PDX-260) and a Hermit Model SE2000C data logger both of which are manufactured by In Situ, Inc. The slug test was done by lowering the 3-foot-long PVC slug down the well to displace the water. After equilibrium between the water level in the well and the aquifer was reached, the slug was quickly removed and the Hermit data logger was started. The data logger records the head pressure above the transducer, and the test is stopped once the amount of head above the transducer has reached its original level (i.e., equilibrium level).

4.0 RESULTS

This section documents the results of the preliminary site characterization, the comparative LNAPL recovery pumping studies, and other supporting tests conducted at the TAFB site.

4.1 Soil Sample Analyses

Table 3 shows the BTEX and TPH content measured in soil samples from the short-term pilot test area. The laboratory analytical report for the soil samples is shown in Appendix C. The concentrations of the BTEX compounds in the soil samples range from 8,100 mg/kg for benzene to

370,000 mg/kg for total xylenes. The purgeable TPH concentration in the soil samples ranged from 2,100 to 15,000 mg/kg. The sieve analyses of the soil samples (see Table 4) indicate that site soil is composed of about 50% sand, 25% silts, and 25% clay. The results of the soil chemistry analyses are summarized in Table 5.

TABLE 3. SOIL SAMPLE ANALYSES FROM TRAVIS AFB, SOIL SAMPLES TAKEN FROM MONITORING POINT A AT BIOSLURPER TEST SITE

Depth (ft)	Paramefer	Detection Limit (mg/kg)	Concentration[(a)] (mg/kg)
MPA-7.0-7.5 ft	TPH (Purgeable)	10	12,000
	Benzene	0.02	63
	Toluene	0.02	220
	Ethylbenzene	0.02	80
	Total Xylenes	0.02	370
MPC-7.0-7.5 ft	TPH (Purgeable)	200	4,200
	Benzene	0.4	22
	Toluene	0.4	84
	Ethylbenzene	0.4	33
	Total Xylenes	0.4	150
MPC-7.5-8.0 ft	TPH (Purgeable)	200	15,000
	Benzene	0.4	8.1
	Toluene	0.4	29
	Total Xylenes	0.4	55
	Ethyl Benzene	0.4	12
MPC-8.0-8.5 ft	TPH (Purgeable)	200	2,100
	Benzene	0.4	9
	Toluene	0.4	38
	Total Xylenes	0.4	80
	Ethyl Benzene	0.4	18

(a) Analysis performed by Alpha Analytical, Inc.

TABLE 4. SOIL SIEVE ANALYSIS FROM TRAVIS AFB, SOIL SAMPLES TAKEN FROM MONITORING POINT AT BIOSLURPER PILOT TEST SITE[a]

	Sand (%)	Silt (%)	Clay (%)
MPA-7.0-7.5 ft	38	33	29
MPC-7.0-7.5 ft	51	24	25
MPC-7.5-8.0 ft	54	22	24
MPC-8.0-8.5 ft	54	23	23

(a) Analysis performed by Alpha Analytical, Inc.

TABLE 5. SOIL SAMPLE ANALYSIS FROM TRAVIS AFB, SOIL MAKEUP FROM MONITORING POINT A AT BIOSLURPER SITE[a]

	MPA-7.0-7.5 ft	MPC-7.0-7.5 ft	MPC-7.5-8.0 ft	MPC-8.0-8.5 ft
pH	9.56	9.53	7.75	7.40
Moisture Content (%)	15.2	14.5	14.5	12.2
Nitrate−N (μg/g)	3.6	2.8	2.0	2.2
Kjeldahl−N (mg/g)	3.3	4.7	4.0	5.3
Phosphorous−total (μg/g)	0.94	1.48	5.61	6.17
Nitrogen−total (mg/g)	3.3	4.7	4.0	5.3
Iron−total (mg/g)	36	30	29	31
Density (g/cm^3)	1.50	1.56	1.32	1.61
Porosity (%)	43.4	41.1	50.2	39.2

(a) Analyses performed by Alpha Analytical, Inc.

4.2 Pilot LNAPL Recovery Test Results

The skimmer pump, bioslurper pump, and drawdown pump test data are summarized in Table 6. LNAPL recovery versus time is plotted for each test configuration on Figure 7, except for the bioslurper mode of operation with the dip tube placed at the oil/water interface. No fuel was recovered during this test because pump failure occurred and the vacuum placed on the well with the

TABLE 6. BIOSLURPER PILOT STUDY AT TRAVIS AFB, FAIRFIELD, CA, EXTRACTION WELL #5303

Data Item	Skimmer Pump Test		Bioslurper Test at Oil/Water Contact[a]		Bioslurper Test at 18 in. Below Oil/Water Contact		Drawdown Test at 18 in. Below Oil/Water Contact		Drawdown Test at 30 in. Below Oil/Water Contact	
Test Duration (days)	1.85		0.62		4.21 3.7 ~~cp~~ p. 20		1.0		2.0	
Medium:	LNAPL	Water	LNAPL	Water	LNAPL	Water	LNAPL	Water	LNAPL	Water
Total Recovered (gal)	0.0	75	0.0	31 35 a.i. data sheet	14.28	1,438	3.25	293	7.53	1,147
Recovery Rate Day 1 (gal/day)	0.0	40	NA	NA	6.78	540	3.25	293	3.38	486
Recovery Rate Day 2 (gal/day)	0.0	35	NA	NA	3.55	353	NA	NA	4.14	661
Recovery Rate Day 3 (gal/day)	NA	NA	NA	NA	4.15	428	NA	NA	NA	NA
Recovery Rate Day 4 (gal/day)	NA	NA	NA	NA	2.54	345	NA	NA	NA	NA
Average Recovery Rate (gal/day)	0.0	40.5	~~4.65~~	1,912	3.85	388	3.2	293	3.76	573.5

(a) Pump failure occurred during this test.

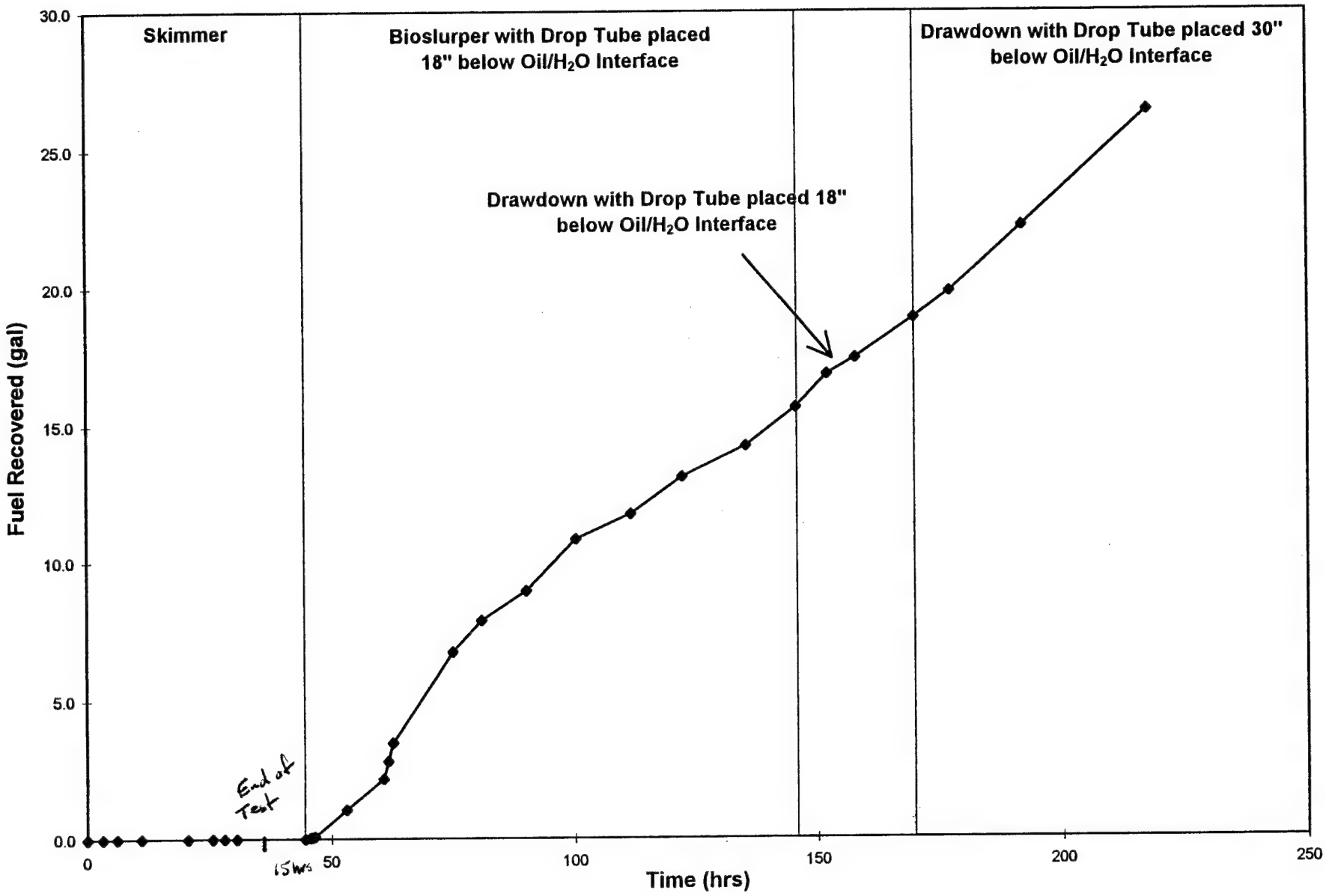


Figure 7. Total LNAPL Recovery as a Function of Time Through the Test Sequence

dip tube at the oil/water interface was insufficient to extract the floating LNAPL. Results for each test configuration are discussed below.

4.2.1 Skimmer Test Results

The bioslurper system was operated in the skimmer simulation mode for approximately 1 day (22.4 hrs). A total of 0 gal LNAPL and 75 gal groundwater were recovered during the test. Therefore, the daily recovery averages equal 0 gal/day for LNAPL and 40 gal/day for groundwater.

4.2.2 Bioslurper (Vacuum-Enhanced) Test Results

The vacuum-enhanced recovery test with the drop tube at the oil/water interface was started approximately 12 hours after the skimmer test was completed. The bioslurper test was run with the drop tube at the oil/water interface for approximately 15 hours, but due to the lack of free-product recovery, the drop tube was lowered to 18 in. below the oil/water interface. While the drop tube was at the interface, 0 gal fuel but 31 gal of water were recovered. These results are not presented in Figure 7 and were not used to calculate the average recovery rate during the bioslurper test.

After lowering the drop tube to 18 in. below the oil/water interface, the system was run in the bioslurper mode for 89 hours (3.71 days). During the vacuum-enhanced recovery configuration, 14.28 gal free product and 1,438 gal water were recovered. The average rates of free-product recovery and groundwater extraction were 3.85 gal/day and 387 gal/day, respectively.

Table 7 presents the system parameters during the bioslurper pump test over time. The table shows that the wellhead vacuum varied between 6 and 24 in. H_2O throughout the bioslurper pump test. This vacuum is equivalent to creating a 6- to 24-in. cone of depression in the water table at the extraction well.

Figure 8 is a graphical representation of the fuel recovery rate during the bioslurper test, which indicates the rate of LNAPL recovery decreased rapidly after the first 2 hours of the beginning of the test. After 2 days of performing the bioslurper test the rates appear to become more constant at a rate of approximately 3 gal fuel/day.

The vapor discharge during the bioslurper test was sampled and analyzed. The vapor discharge rate for the bioslurper test was approximately 28,000 ft^3/day (20 cfm). Based on the analyses and the vapor discharge rate, approximately 126 lb/day of TPH was emitted to the air during the bioslurper test. An off-gas composition measurement at the beginning of the vacuum-enhanced test indicates that the CO_2 and O_2 concentrations were near ambient.

TABLE 7. SYSTEM PARAMETERS DURING THE VACUUM-ENHANCED MODE OF THE TEST. INCLUDED ARE DATA ON THE WELLHEAD VACUUM. 18' below

Date/Time		Run Time (min)	Vapor Extraction			Pump Stack Temp. (°C)	Pump Head Vacuum (in Hg)	Slurper Vacuum (in H_2O)	Tank Temp. (°C)	Tank Press. (psi)	Field OVA? Stack TPH (ppm)	Stack O_2 (%)	Stack CO_2 (%)
month/ day/ year	hr:min		Stack Pressure (in H_2O)	Carbon Drums (in H_2O)	Flow Rate (scfm)								
1/17/95	17:40	0	–	–	–	–	23.0	17.0	–	–	5,800.0	21.0	0.6
1/17/95	18:40	60	0.5	–	20.00	14.7	17.5	19.00	–	–	–	–	–
1/17/95	19:40	120	0.5	–	20.00	–	17.0	20.0	–	–	–	–	–
1/17/95	21:45	245	0.3	–	20.00	13.7	17.0	20.0	–	–	–	–	–
1/18/95	8:00	860	0.3	–	20.00	9.1	16.5	–	–	–	8,000.0	–	–
1/18/95	13:57	1,217	0.6	–	20.00	17.2	17.0	20.0	–	–	–	–	–
1/19/95	14:45	2,705	0.0	–	20.00	–	6.0	7.0	–	–	–	–	–
1/19/95	0:00	1,820	–	–	–	–	7.0	–	–	–	–	–	–
1/20/95	10:45	3,905	0.5	–	20.00	25.3	8.0	8.0	26.8	–	–	–	–
1/20/95	22:00	4,580	0.3	–	20.00	–	10.0	10.0	–	–	–	–	–
1/21/95	8:30	5,210	0.3	–	20.0	25.8	10.0	7.0	27.5	–	–	–	–
1/21/95	21:45	6,005	–	–	20.0	26.0	11.0	11.0	27.7	–	–	–	–

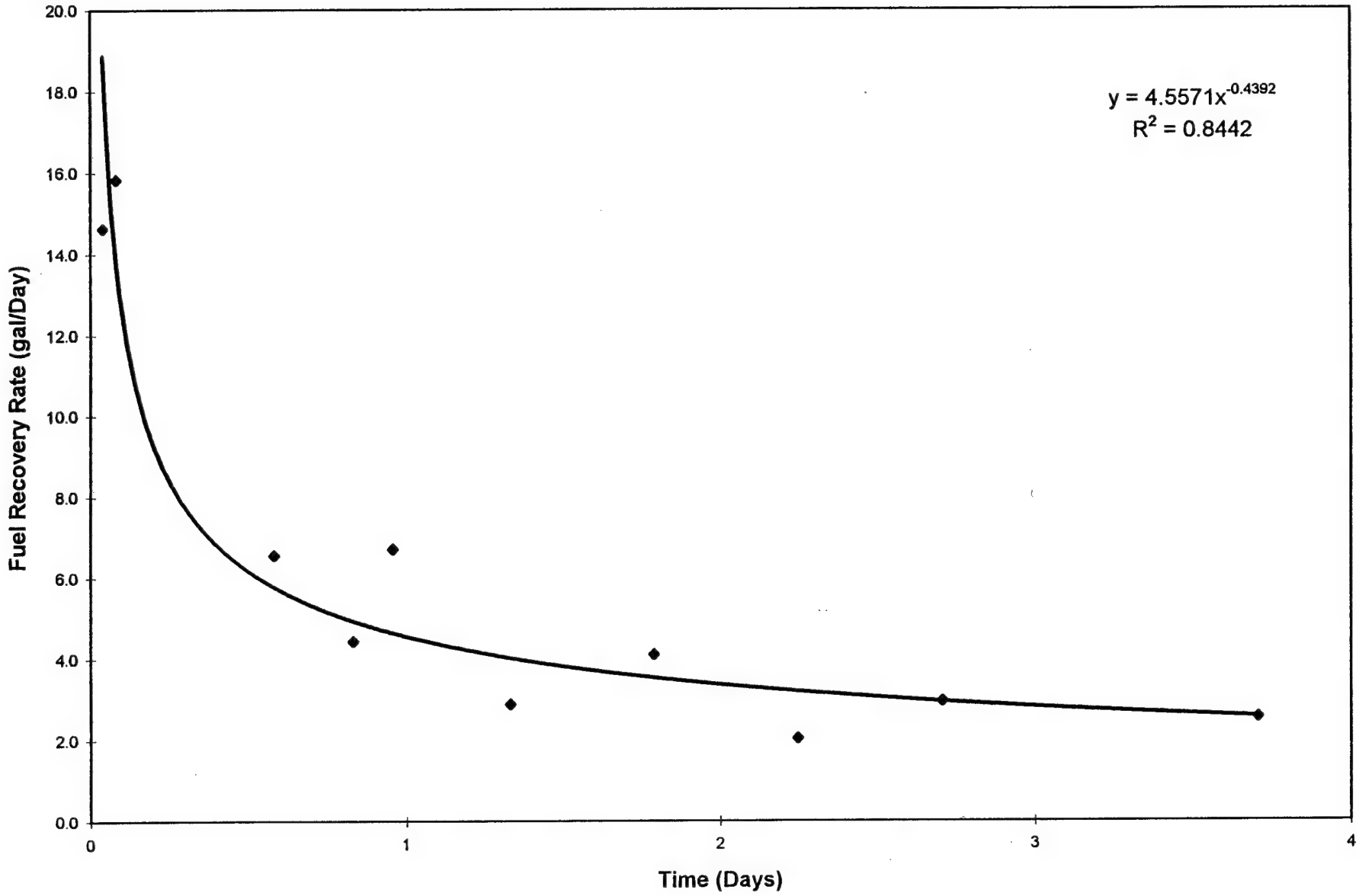


Figure 8. Free-Product Recovery Rate Throughout the Bioslurper Test

4.2.3 Drawdown LNAPL Recovery Test

The drawdown recovery test was performed with the drop tube at 18 in. below the oil/water interface and at 30 in below the oil/water interface. The test with the drop tube at 18 in. below the interface was used as a comparison for the vacuum-enhanced test with the drop tube set at the same level. The drawdown test with the drop tube 18 in. below the oil/water interface was run for 24 hours and the drawdown test with the drop tube placed at 30 in. below the interface was run for 48 hours.

The total recovery with the drop tube at 18 in. below the interface was 3.25 gal of free product and 293 gal groundwater. Therefore, the rate of recovery is 3.25 gal/day for free product and 293 gal/day for groundwater. The recovery rate of free product remained nearly constant during the test.

While the drop tube was at 30 in. below the interface, 7.53 gal free product was recovered and 661 gal water was extracted. The average rate of recovery was 3.76 gal/day and 573 gal/day for free product and water, respectively.

4.3 LNAPL, Groundwater Discharge, and Vapor Discharge Analyses

During the operation of the bioslurper pump test, water and fuel samples were collected. The free product samples were collected from the extraction well before starting the vacuum-enhanced recovery test, and the water samples were collected from the water discharge pipe leading from the oil/water separator. The analyses of these fuel and water samples were performed by Alpha Analytical, Inc. The fuel composition is shown in Tables 8 and 9. The contaminant concentration in the water from the oil/water separator is displayed in Table 10. In addition, vapor samples were collected from the bioslurper system vapor discharge stack. The analysis of the vapor samples was done by Air Toxics, Inc. The results from the vapor discharge samples are presented in Table 11. The laboratory analytical reports for all analyses are presented in Appendix C.

4.4 Slug Test Results

Figure 9 presents the data from the slug tests performed on well #5303. The raw data and replicate slug test data and results are shown in Appendix F. The hydraulic conductivity of the area surrounding well #5303 based on the results of the slug tests was 0.23 ft per day. As stated previously, the soils near the extraction well are composed of clay-rich silts and sands. The results from the slug test can be used to determine the efficiency of the bioslurper system operating in soils

TABLE 8. BTEX FUEL ANALYSIS FROM TRAVIS AFB RECOVERED FUEL FROM BIOSLURPER PILOT TEST ON WELL #5303

COMPOUND	METHOD	DETECTION LIMIT (μg/kg)	CONCENTRATION[a] (μg/kg)
Benzene	8240	490	2,000
Toluene	8240	490	11,000
Ethylbenzene	8240	490	8,000
Total Xylenes	8240	490	35,000

(a) Analyses performed by Alpha Analytical, Inc.

TABLE 9. C-RANGE COMPOUNDS FROM FUEL ANALYSIS FROM TRAVIS AFB RECOVERED FUEL FROM BIOSLURPER PILOT TEST ON WELL #5303

C-RANGE COMPOUNDS	METHOD	PERCENTAGE OF TOTAL[a]
C9 and <	GC/FID	47.25
C9	GC/FID	21.55
C10	GC/FID	13.88
C11	GC/FID	6.54
C12	GC/FID	3.80
C13	GC/FID	3.03
C14	GC/FID	2.15
C15	GC/FID	0.95
C16	GC/FID	0.37
C17	GC/FID	0.47

(a) Analysis performed by Alpha Analytical, Inc.

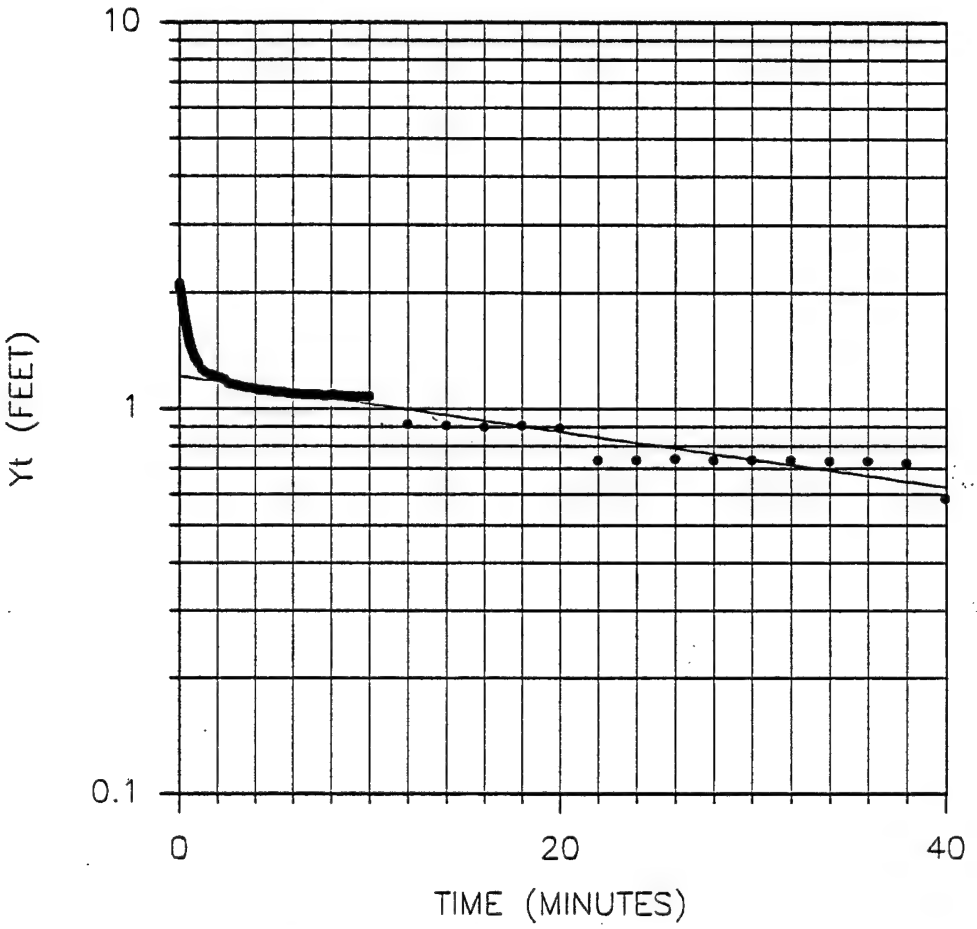
TABLE 10. GROUNDWATER SAMPLE ANALYSIS FROM TRAVIS AFB, GROUNDWATER SAMPLE TAKEN FROM OIL/WATER SEPARATOR WATER DISCHARGE STREAM DURING BIOSLURPER PILOT TEST

SAMPLE	DAY OF TEST	PARAMETER	DETECTION LIMIT (mg/L)	CONCENTRATION (mg/L)[a]
JFSA-1-WS-1	1	TPH (Purgeable)	5.0	11
		Benzene	0.01	0.91
		Toluene	0.01	1.8
		Ethylbenzene	0.01	0.51
		Total Xylenes	0.01	2.80
JFSA-1-WS-2	2	TPH (Purgeable)	5.0	16
		Benzene	0.01	1.10
		Toluene	0.01	2.50
		Ethylbenzene	0.01	0.78
		Total Xylenes	0.01	4.30
JFSA-1-WS-3	4	TPH (Purgeable)	5.0	20
		Benzene	0.01	1.00
		Toluene	0.01	2.10
		Ethylbenzene	0.01	0.71
		Total Xylenes	0.01	4.00
JFSA-1-WS-4	4	TPH (Purgeable)	5.0	20
		Benzene	0.01	1.10
		Toluene	0.01	2.50
		Ethylbenzene	0.01	0.81
		Total Xylenes	0.01	4.40

(a) Analyses performed by Alpha Analytical, Inc.

TABLE 11. DISCHARGE VAPOR ANALYSIS FROM TRAVIS AFB BIOSLURPER PILOT TEST; SAMPLES TAKEN FROM BIOSLURPER STACK

SAMPLE	DAY OF TEST	PARAMETER	METHOD	DETECTION LIMIT (mg/L)	CONCENTRATION (ppmv)
JFSA-1-OGS-1	1	TPH (as jet fuel)	GC/FID	16	10,000
		Benzene	GC/FID	1.6	93
		Toluene	GC/FID	1.6	200
		Ethylbenzene	GC/FID	1.6	260
		Total Xylenes	GC/FID	1.6	64
JFSA-1-OGS-2	3	TPH (as jet fuel)	GC/FID	16	10,000
		Benzene	GC/FID	1.6	96
		Toluene	GC/FID	1.6	190
		Ethylbenzene	GC/FID	1.6	59
		Total Xylenes	GC/FID	1.6	230
JFSA-1-OGS-3	1	TPH (as jet fuel)	GC/FID	16	9,200
		Benzene	GC/FID	1.6	79
		Toluene	GC/FID	1.6	180
		Ethylbenzene	GC/FID	1.6	56
		Total Xylenes	GC/FID	1.6	230
JFSA-1-OGS-4	3	TPH (as jet fuel)	GC/FID	16	14,000
		Benzene	GC/FID	1.6	130
		Toluene	GC/FID	1.6	290
		Ethylbenzene	GC/FID	1.6	79
		Total Xylenes	GC/FID	1.6	310



Bouwer and Rice Slug Test Analysis						
Well 5303 - Replicate #1						
D =	37	ft				
L =	15	ft				
H =	12.39	ft				
rw =	1.25	ft				
rc =	0.5	ft				
L/rw =	12.00			ln Re/rw =	1.05	
A =	2			Re =	3.56	
B =	1.25					
t =	18	min		K =	0.20	ft/day
Yt =	0.9	ft				
Yo =	1.2	ft				

Figure 9. Level Variation During an Example Slug Test in Well #5303

with relatively low hydraulic conductivities. These results will be used to compare the efficiency of the bioslurping at this site with bioslurping in other sites that possess different lithologies and hydraulic conductivities.

4.5 Bioventing Analyses

4.5.1 Soil Gas Permeability and Radius of Influence

The raw data collected during the soil gas permeability test are shown in Appendix D. Using the steady-state method for calculating soil gas permeability, a soil gas permeability of 0.16 darcys was determined.

The radius of influence is calculated by plotting the log of the pressure change at a specific monitoring point versus the distance from the extraction well. The radius of influence would then be the distance where 0.1 in. of H_2O can be measured. Therefore, the radius of influence based on these specifications is 55.3 ft (see Figure 10).

4.5.2 In Situ Respiration Test

The raw data collected during the in situ respiration test are compiled in Appendix E. Figure 11 illustrates the variation of oxygen, carbon dioxide, and helium in the soil gas during the in situ respiration test. A summary of the oxygen utilization and carbon dioxide production rates and the corresponding biodegradation rates is shown as Table 12. The biodegradation rates measured at this site ranged from 61 to 82 mg (hexane equivalents)/kg (soil)/day based on oxygen utilization.

TABLE 12. OXYGEN UTILIZATION RATES DURING THE IN SITU RESPIRATION TEST AT TRAVIS AFB

MONITORING POINT	OXYGEN UTILIZATION RATE (%/hr)	BIODEGRADATION RATE (mg/kg/day)
MPA-5.5	3.14	61
MPB-8	3.14	61
MPC-5.5	4.28	82

Loss of helium was insignificant at all monitoring points, indicating that the monitoring points were well sealed and that the oxygen depletion observed was a result of biodegradation.

Radius of Influence

Site Name Travis AFB

Date: 1/17/95

Time (min.)	Air Flow (cfm)	Vacuum (inches of water)													
		green	blue	red	green	blue	red	blue	black	clear	orange	yellow	blue	green	red
0.00		0.00	0.00	0.00	0.00	0.00	0.00								
9.00		0.00	0.14	0.01	0.03	0.09	0.00								
31.00		0.00	0.34	0.33	0.04	0.18	0.01								
60.00		0.00	0.55	0.55	0.13	0.35	0.22								
105.00		0.00	0.70	0.70	0.15	0.40	0.30								
120.00		0.00	0.70	0.65	0.15	0.40	0.30								
240.00		0.55	0.95	0.95	0.16	0.50	0.40								
Distance (ft)		10	10	10	30	30	30								

R_I: 55.28 ft

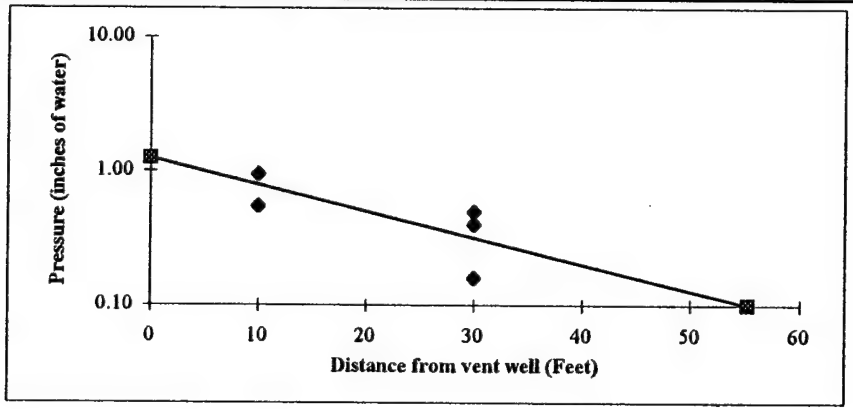


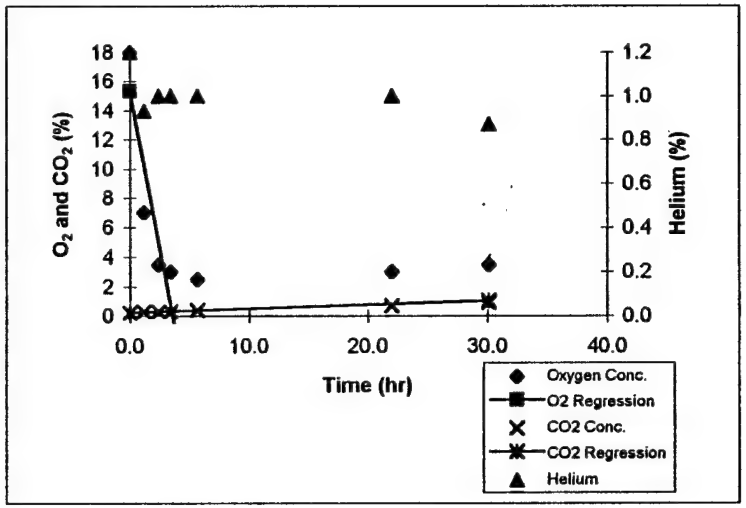
Figure 10. Soil Gas Pressure as a Function of Distance

Utilization Rates (3)

Date: 1/23/95 **Site Name:** Travis AFB

Monitoring Point: MPC **Depth of M.P. (ft):** 5.5

Date/Time (mm/dd/yr hr:min)	Time (hr)	Oxygen (%)	Carbon Dioxide (%)	Helium (%)
1/23/95 11:05	0.0	18.00	0.20	1.20
1/23/95 12:15	1.2	7.00	0.30	0.93
1/23/95 13:30	2.4	3.50	0.30	1.00
1/23/95 14:30	3.4	3.00	0.30	1.00
1/23/95 16:45	5.7	2.50	0.40	1.00
1/24/95 9:05	22.0	3.00	0.70	1.00
1/24/95 17:10	30.1	3.50	0.90	0.87



O_2 Utilization Rate

Ko	0.071 %/min
	4.264 %/hr
	102.340 %/day

Regression Lines	O_2	CO_2
Slope	-4.2642	0.0264
Intercept	15.3373	0.2288
Determination Coef.	0.8240	0.6164
No. of Data Points.	4	4

Figure 11. Soil Gas Composition Variation During an In Situ Respiration Test

5.0 DISCUSSION OF RESULTS

Free-product recovery was limited to the configurations of the bioslurper system that had the drop tube extending below the oil/water interface. In the skimmer test and the bioslurper test with the drop tube placed at the oil/water interface, no free product was recovered and the amount of water extracted was much less than in tests run with the drop tube placed below the interface. Heavy rains during the tests affected the level of the water table near the site, which appeared to prevent the recovery of free product during the skimmer and bioslurper tests with the drop tube at the oil/water interface. It was decided that the water table needed to be lowered in order to recover free product. Therefore, the drop tube was placed at 18 in. below the oil/water interface for the bioslurper test.

The appearance of free-product recovery when the drop pipe is lowered to below the interface is attributed to the cone of depression that is formed by decreasing the water level within the extraction well. The results demonstrate that the presence of a vacuum within the extraction increases the average rate of free-product recovery compared to a nonvacuum drawdown extraction. During the first day of vacuum-enhanced extraction the fuel recovery rate computed to 6.78 gal/day. This was significantly higher than the fuel recovery rate for the drawdown modes of LNAPL recovery. Also, at the end of the 4-day bioslurper test, the recovery rate (3.85 gal/day) was still greater than either drawdown tests' recovery rates (3.20 gal/day at 9.7 bgs, 3.76 gal/day at 10.7 bgs). In addition, the vacuum-enhanced pilot test increased the oxygen concentrations in the vadose zone to above oxygen-limited conditions, or to greater than 5% O_2. In situ respiration tests indicated an average biodegradation rate of 68 mg/kg/day would be produced if oxygen concentrations were not limited.

Installation of the bioslurper system would likely enhance free product removal at JFSA-1 at Travis AFB. Additionally, in situ biodegradation of vadose zone contamination would be promoted by the increase in oxygen concentrations in the vadose zone. The feasibility of implementing a bioslurper system at Travis AFB is dependent on regulations for the discharge of vapor and the disposition of the extracted groundwater.

6.0 EXTENDED TESTING AT TRAVIS AFB

Currently, plans are being made to initiate the extended bioslurper test at Travis AFB that will continue for 1 month after the startup date. Arrangements are being made to connect the bioslurper system to electric power at the site and to connect wells #5302 and WS001V03 to the bioslurper

extraction system. The primary purpose of the extended test is to optimize system operation for the expanded-scale bioslurping. Specific concerns that will be addressed during the system optimization include proper placement of the drop tube and disposition of the vapor and aqueous discharge from the bioslurper system.

Alternatives to direct release of the extracted vapors are reinjection or destruction in an internal combustion engine. The site-specific test plan contains the specific arrangement and the benefits of both these treatment methods. Based on data from the short-term pilot test, it is estimated that 126 lb/day of TPH will be produced during operation of the bioslurper. Reinjection may prove to be a viable option because of the large biodegradation rates and the relatively large radius of influence. Oxygen utilization rates averaged 3.52%/hour for the three monitoring points used in the respiration test; the radius of influence is 55 feet.

If the extracted vapors are reinjected into the ground, the configuration of the bioslurper system will be such that surface emissions of vapors will be minimized and the subsurface oxygen distribution will be maximized for bioventing. The bioslurper system will be set up to extract from the free-product recovery wells (FPRWs) on site. The stack vapor will be plumbed to reinject vapor into an existing vapor monitoring well. A pressure/vapor monitoring point will be installed on the reinjection well to monitor injection pressure and hydrocarbon concentrations. Most of the vapors that are reinjected will be recaptured by the bioslurper system because of the relatively large radius of influence of the bioslurper extraction wells. Such a flow pattern creates a closed system for the vapors. However, a surface emissions test will be conducted to determine the mass of hydrocarbons emitted at the surface and to confirm that hydrocarbons are in fact being treated in situ.

It is expected that approximately 0.4 gal groundwater will be extracted per minute per well. At this extraction rate, it may be feasible the discharge the groundwater directly to the sanitary sewage system. Base personnel have indicated that the charge for discharge of groundwater to the sanitary sewer will be $0.05/gal.

7.0 EXPANDED TESTING AT TRAVIS AFB

Based on the results of the extended tests, recommendations will be provided on expanded-scale testing. If expanded-scale testing is feasible, a test plan will be developed outlining specific procedures for long-term operation of the system. It is expected that all of the free-product recovery wells will be connected to the bioslurper system, and that free-product recovery will last approximately 1 year.

8.0 REFERENCES

Battelle. 1995. *Test Plan and Technical Protocol for Bioslurping*. Report to U.S. Air Force, Brooks AFB, Texas. January 30, 1995.

Hinchee, R.E., S.K. Ong, R.N. Miller, and D.C. Downey. 1992. *Test Plan and Technical Protocol for a Field Treatability Test for Bioventing*. Report to U.S. Air Force Center for Environmental Excellence, Brooks AFB, Texas.

APPENDIX A

SYSTEM CHECKLIST

Checklist for System Shakedown

Site: Travis, AFB

Date: Jan 15 '95

Operator's Initials: D.C.F & M.P.

Equipment	Check if Okay	Comments
Liquid Ring Pump	✓	pump failure occured during biosluper test, replaced
Aqueous Effluent Transfer Pump	✓	
Oil/Water Separator	✓	
Vapor Flowmeter	✓	
Fuel Flowmeter		broken used grad. cylinder
Water Flowmeter	✓	
Emergency Shut off Float Switch Effluent Transfer Tank		float switch by-passed
Analytical Field Instrumentation GasTector™ O_2/CO_2 Analyzer ✓ TraceTector™ Hydrocarbon Analyzer ✓ Oil/Water Interface Probe ✓ Magnehelic Boards ✓ Thermocouple Thermometer ✓	✓	

APPENDIX B

DATA SHEETS FROM THE SHORT-TERM PILOT TEST

Depth to GW: _____
Depth to Tube: _____

Fuel and Water Recovery Data

Site: Travis AFB **Start Date:** 1/12/95
Test Type: Skimmer **Operaters:** Place/Foor

Date/Time (mm/dd/yr hr:min)	Elapsed Time (min)	LNAPL Recovery				Groundwater Recovery			
		Collected (gal)	Total (gal)	Rate (gpm)	Avg. Rate (gpm)	Collected (gal)	Total (gal)	Rate (gpm)	Avg. Rate (gpm)
1/12/95 10:55	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1/12/95 14:00	185	0.00	0.00	0.00	0.00	0	0.00	0.00	0.00
1/12/95 17:00	365	0.00	0.00	0.00	0.00	10	10.00	0.03	0.03
1/12/95 22:00	665	0.00	0.00	0.00	0.00	5	15.00	0.01	0.02
1/13/95 7:30	1235	0.00	0.00	0.00	0.00	5	20.00	0.00	0.02
1/13/95 12:30	1535	0.00	0.00	0.00	0.00	20	40.00	0.01	0.03
1/13/95 15:00	1685	0.00	0.00	0.00	0.00	10	50.00	0.01	0.03
1/13/95 17:30	1835	0.00	0.00	0.00	0.00	10	60.00	0.01	0.03
1/14/95 7:30	2675	0.00	0.00	0.00	0.00	15	75.00	0.01	0.03
Total Hours	44.58	**Rate (GPH)**	0.00			**Rate (GPH)**	1.68		

Pumping Test Data

Site: Travis AFB
Operators:
Test Type: Skimmer

Start Date: 12-Jan-95
Start Time: 10:55
Well ID: 5303

Depth to GW (ft):
Depth to Tube (ft):

Depth to Fuel (ft):

Date/Time (mm/dd/yr hr:min)	Run Time (min.)	Vapor Extraction			Pump Stack Temp. (°C)	Pump Head Vacuum (in Hg)	Tank Temp. (°C)	Tank Press. (psi)	Stack TPH (ppm)	Stack 0_2 (%)	Stack CO_2 (%)
		Stack Pressure (in H_2O)	Carbon Drums (in H_2O)	Flow rate (scfm)							
1/12/95 10:55	0	17.5				18.5					
1/12/95 14:00	185	10.0				20.0			200.0		
1/12/95 22:00	665	5.0				20.0					
1/13/95 7:30	1235	4.5				20.0					
1/13/95 12:30	1535	5.0				20.0					
1/13/95 15:00	1685	5.0				20.0					
1/13/95 17:30	1835	5.0				20.0					
1/13/95 7:30	1235	5.0				21.0					
1/13/95 12:00	1505	5.0				20.0					

Fuel and Water Recovery Data

Site: Travis AFB **Start Date:** 1/14/95

Test Type: Vacuum Enhancement **Operaters:** Place/Foor

Date/Time (mm/dd/yr hr:min)	Elapsed Time (min)	LNAPL Recovery				Groundwater Recovery			
		Collected (gal)	Total (gal)	Rate (gpm)	Avg. Rate (gpm)	Collected (gal)	Total (gal)	Rate (gpm)	Avg. Rate (gpm)
1/14/95 20:30	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1/15/95 5:00	510	0.00	0.00	0.00	0.00	25	25.00	0.05	0.05
1/15/95 10:00	810	0.00	0.00	0.00	0.00	5	30.00	0.01	0.04
1/15/95 12:00	930	0.00	0.00	0.00	0.00	5	35.00	0.01	0.04
Total Hours	15.50	**Rate (GPH)**	0.00			**Rate (GPH)**	2.26		

Fuel and Water Recovery Data

Site: Travis AFB **Start Date:** 1/17/95

Test Type: Vacuum Enhancement **Operaters:** Place/Foor

Date/Time (mm/dd/yr hr:min)	Elapsed Time (hours)	LNAPL Recovery				Groundwater Recovery			
		Collected (gal)	Total (gal)	Rate (gpd)	Avg. Rate (gpd)	Collected (gal)	Total (gal)	Rate (gpd)	Avg. Rate (gpd)
1/17/95 17:40	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1/17/95 18:40	1	0.61	0.61	14.64	14.64	0	0.00	0.00	0.00
1/17/95 19:40	2	0.66	1.27	7.92	15.24	64	64.00	768.00	768.00
1/18/95 8:00	14	3.28	4.55	5.62	7.80	254	318.00	435.43	545.14
1/18/95 14:00	20	1.11	5.66	1.33	6.79	132	450.00	158.40	540.00
1/18/95 17:00	23	0.84	6.50	0.88	6.78	66	516.00	68.87	538.43
1/19/95 14:45	23	0.00	6.50	0.00	6.78	0	516.00	0.00	538.43
1/20/95 0:00	32	1.08	7.58	0.81	5.69	149	665.00	111.75	498.75
1/20/95 10:45	43	1.88	9.46	1.05	5.28	145	810.00	80.93	452.09
1/20/95 22:00	54	0.93	10.39	0.41	4.62	142	952.00	63.11	423.11
1/21/95 8:30	65	1.35	11.74	0.50	4.33	141	1093.00	52.06	403.57
1/22/95 8:00	89	2.54	14.28	0.68	3.85	345	1438.00	93.03	387.78
Total Hours	89.00	**Rate (GPH)**	0.16	**Rate (GPD)**	3.85	**Rate (GPH)**	16.16	**Rate (GPD)**	387.78

Pumping Test Data

Site: Travis AFB
Operators: Place/Foor
Test Type: Vacuum Enhancement

Depth to GW (ft): _____ **Depth to Fu**
Depth to Tube (ft): _____

Date/Time (mm/dd/yr hr:min)	Run Time (min)	Vapor Extraction			Pump Stack Temp. (°C)	Pump Head Vacuum (in Hg)	Slurper Vacuum (in H_2O)	Tank Temp. (°C)
		Stack Pressure (in H_2O)	Carbon Drums (in H_2O)	Flow rate (scfm)				
1/17/95 17:40	0	-	-	-	-	23.0	17.0	-
1/17/95 18:40	60	0.5	-	20.00	14.7	17.5	19.0	-
1/17/95 19:40	120	0.5	-	20.00	-	17.0	20.0	-
1/17/95 21:45	245	0.3	-	20.00	13.7	17.0	20.0	-
1/18/95 8:00	860	0.3	-	20.00	9.1	16.5	-	-
1/18/95 13:57	1217	0.6	-	20.00	17.2	17.0	20.0	-
1/19/95 14:45	2705	0.0	-	20.00	-	6.0	7.0	-
1/19/95 0:00	1820	-	-	-	-	7.0	-	-
1/20/95 10:45	3905	0.5	-	20.00	25.3	8.0	8.0	26.8
1/20/95 22:00	4580	0.3	-	20.00	-	10.0	10.0	-
1/21/95 8:30	5210	0.3	-	20.00	25.8	10.0	7.0	27.5
1/21/95 21:45	6005	-	-	20.00	26.0	11.0	11.0	27.7

Fuel and Water Recovery Data

Site: Travis AFB **Start Date:** 1/23/95

Test Type: Drawdown **Operaters:** Place/Foor

Date/Time (mm/dd/yr hr:min)	Elapsed Time (min)	LNAPL Recovery				Groundwater Recovery			
		Collected (gal)	Total (gal)	Rate (gpm)	Avg. Rate (gpm)	Collected (gal)	Total (gal)	Rate (gpm)	Avg. Rate (gpm)
1/23/95 10:00	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1/23/95 16:30	390	1.21	1.21	0.00	0.00	0	0.00	0.00	0.00
1/23/95 22:15	735	0.58	1.79	0.00	0.00	541	541.00	0.74	0.74
1/24/95 10:00	1440	1.45	3.24	0.00	0.00	569	1110.00	0.40	0.77
Total Hours	24.00	**Rate (GPH)**	0.14			**Rate (GPH)**	46.25		

Pumping Test Data

Are these correct? Compare to Table 2

Site: Travis AFB
Operators: Place/Foor
Test Type: Drawdown

Depth to GW (ft): 8.16
Depth to ~~Tube~~ Fuel (ft): 8.20

Start W

Tube

Depth to ~~Fuel~~ (ft): 9.70

Date/Time (mm/dd/yr hr:min)	Run Time (min)	Vapor Extraction			Pump Stack Temp. (°C)	Pump Head Vacuum (in Hg)	Tank Temp. (°C)	Tank Press. (psi)	Stack TPH (ppm)
		Stack Pressure (in H_2O)	Carbon Drums (in H_2O)	Flow rate (scfm)					
1/23/95 10:00	0	nd	-	nd	nd	6.0	-	-	-
1/23/95 22:15	735	0.2	-	20.0	24.8	5.0	-	-	-
1/24/95 10:00	1440	0.2	-	20.0	26.4	6.0	-	-	-

Fuel and Water Recovery Data

Site: Travis AFB **Start Date:** 1/24/95

Test Type: Drawdown **Operaters:** Place/Foor

Date/Time (mm/dd/yr hr:min)	Elapsed Time (min)	LNAPL Recovery				Groundwater Recovery			
		Collected (gal)	Total (gal)	Rate (gpm)	Avg. Rate (gpm)	Collected (gal)	Total (gal)	Rate (gpm)	Avg. Rate (gpm)
1/24/95 10:25	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1/24/95 17:40	435	0.97	0.97	0.00	0.00	162	162.00	0.37	0.37
1/25/95 8:45	1340	2.41	3.38	0.00	0.00	324	486.00	0.24	0.36
1/26/95 10:30	2885	4.14	7.52	0.00	0.00	661	1147.00	0.23	0.40
Total Hours	48.08	**Rate (GPH)**	0.16			**Rate (GPH)**	23.85		

Pumping Test Data

Site: Travis AFB
Operators: Place/Foor
Test Type: Drawdown

Start
Start
W

Depth to GW (ft): 8.16
Depth to ~~Tube~~ Fuel (ft): 8.20

Tube
Depth to ~~Fuel~~ (ft): 10.70

Date/Time (mm/dd/yr hr:min)	Run Time (min)	Vapor Extraction			Pump Stack Temp. (°C)	Pump Head Vacuum (in Hg)	Tank Temp. (°C)	Tank Press. (psi)	Stack TPH (ppm)
		Stack Pressure (in H_2O)	Carbon Drums (in H_2O)	Flow rate (scfm)					
1/24/95 10:24	0	0.1	-	20.0	nd	10.0	-	-	-
1/24/95 17:40	436	nd	-	nd	23.8	6.0	-	-	-
1/25/95 8:45	1341	0.2	-	20.0	24.5	6.0	-	-	-
1/26/95 10:30	2886	0.2	-	20.0	18.8	6.0	-	-	-

APPENDIX C

ANALYTICAL DATA REPORTS

Alpha Analytical, Inc.
255 Glendale Avenue, Suite 21
Sparks, Nevada 89431
(702) 355-1044
FAX: 702-355-0406
1-800-283-1183

Boise, Idaho
(208) 336-4145

Las Vegas, Nevada
(702) 386-6747

ANALYTICAL REPORT

Battelle
505 King Ave
Columbus Ohio 43201

Job#: 9462201/Travis AFB
Phone: (614) 424-6122
Attn: Jeff Kittel

Sampled: 01/11/95 Received: 01/23/95 Analyzed: 01/23-24/95

Matrix: [X] Soil [ ] Water [ ] Waste

Analysis Requested: TPH - Total Petroleum Hydrocarbons-Purgeable Quantitated As Gasoline
BTXE - Benzene, Toluene, Xylenes, Ethylbenzene

Methodology: TPH - Modified 8015/DHS LUFT Manual/BLS-191
BTXE - Method 624/8240

Results:

Client ID/ Lab ID	Parameter	Concentration	Detection Limit
JFSA-1-MPA-1 /BMI012395-01	TPH (Purgeable)	12,000	1,000 mg/Kg
	Benzene	63,000	2,000 ug/Kg
	Toluene	220,000	2,000 ug/Kg
	Total Xylenes	370,000	2,000 ug/Kg
	Ethylbenzene	80,000	2,000 ug/Kg
JFSA-1-MPC-1 /BMI012395-02	TPH (Purgeable)	4,200	1,000 mg/Kg
	Benzene	22,000	2,000 ug/Kg
	Toluene	84,000	2,000 ug/Kg
	Total Xylenes	150,000	2,000 ug/Kg
	Ethylbenzene	33,000	2,000 ug/Kg
JFSA-1-MPC-2 /BMI012395-03	TPH (Purgeable)	1,500	1,000 mg/Kg
	Benzene	8,100	2,000 ug/Kg
	Toluene	29,000	2,000 ug/Kg
	Total Xylenes	55,000	2,000 ug/Kg
	Ethylbenzene	12,000	2,000 ug/Kg
JFSA-1-MPC-3 /BMI012395-04	TPH (Purgeable)	2,100	1,000 mg/Kg
	Benzene	9,500	2,000 ug/Kg
	Toluene	38,000	2,000 ug/Kg
	Total Xylenes	80,000	2,000 ug/Kg
	Ethylbenzene	18,000	2,000 ug/Kg

Approved by: Roger L. Scholl Date: 2/2/95
Roger L. Scholl, Ph.D.
Laboratory Director

Alpha Analytical, Inc.
255 Glendale Avenue, Suite 21
Sparks, Nevada 89431
(702) 355-1044
FAX: 702-355-0406
1-800-283-1183

Boise, Idaho
(208) 336-4145

Las Vegas, Nevada
(702) 386-6747

ANALYTICAL REPORT

Battelle
505 King Ave
Columbus Ohio 43201

Job#: 9462201/Travis AFB
Phone: (614) 424-6122
Attn: Jeff Kittel

Sampled: 01/18-20/95 Received: 01/23/95 Analyzed: 01/26/95

Matrix: [ ] Soil [X] Water [ ] Waste

Analysis Requested: TPH - Total Petroleum Hydrocarbons-Purgeable Quantitated As Gasoline
BTXE - Benzene,Toluene,Xylenes,Ethylbenzene

Methodology: TPH - Modified 8015/DHS LUFT Manual/BLS-191
BTXE - Method 624/8240

Results:

Client ID/ Lab ID	Parameter	Concentration	Detection Limit
JFSA-1-WS-1 /BMI012395-05	TPH (Purgeable)	11	5.0 mg/L
	Benzene	910	10 ug/L
	Toluene	1,800	10 ug/L
	Total Xylenes	2,800	10 ug/L
	Ethylbenzene	510	10 ug/L
JFSA-1-WS-2 /BMI012395-06	TPH (Purgeable)	16	5.0 mg/L
	Benzene	1,100	10 ug/L
	Toluene	2,500	10 ug/L
	Total Xylenes	4,300	10 ug/L
	Ethylbenzene	780	10 ug/L
JFSA-1-WS-3 /BMI012395-07	TPH (Purgeable)	20	5.0 mg/L
	Benzene	1,000	10 ug/L
	Toluene	2,100	10 ug/L
	Total Xylenes	4,000	10 ug/L
	Ethylbenzene	710	10 ug/L

Approved by: Roger L. Scholl Date: 2/2/95
Roger L. Scholl, Ph.D.
Laboratory Director

Alpha Analytical, Inc.

2722 Glendale Avenue, Suite 21
Sparks, Nevada 89431
(702) 355-1044
FAX: 702-355-0406
1-800-283-1183

Boise, Idaho
(208) 336-4145

Las Vegas, Nevada
(702) 386-6747

ANALYTICAL REPORT

Battelle
505 King Ave
Columbus Ohio 43201

Job#: G466201-37D0701 (Travis AFB)
Phone: (614) 424-6122
Attn: Eric Drescher

Alpha Analytical Number: BMI020395-02

Client I.D. Number: JFSA-1-FP-2

Compound	Method	Concentration ug/Kg	Detection Limit ug/Kg	Date Analyzed
Benzene	8240	2,000.000	490.000	02/03/95
Toluene	8240	11,000.000	490.000	02/03/95
Total Xylenes	8240	35,000.000	490.000	02/0395
Ethylbenene	8240	8,000.000	490.000	02/03/95
C-range Compounds	Method	Percentage of Total	Detection Limit (Not Applicable)	Date Analyzed
C9<	GC/FID	47.25	NA	02/06/95
C9	GC/FID	21.55	NA	02/06/95
C10	GC/FID	13.88	NA	02/06/95
C11	GC/FID	6.54	NA	02/06/95
C12	GC/FID	3.80	NA	02/06/95
C13	GC/FID	3.03	NA	02/06/95
C14	GC/FID	2.15	NA	02/06/95
C15	GC/FID	0.95	NA	02/06/95
C16	GC/FID	0.37	NA	02/06/95
C17>	GC/FID	0.47	NA	02/06/95

ND - Not Detected

Approved by: Roger L. Scholl

Roger L. Scholl, Ph.D.
Laboratory Director

Date: 2/16/95

Alpha Analytical, Inc.
255 Glendale Avenue, Suite 21
Sparks, Nevada 89431
(702) 355-1044
FAX: 702-355-0406
1-800-283-1183

Boise, Idaho
(208) 336-4145

Las Vegas, Nevada
(702) 386-6747

ANALYTICAL REPORT

Battelle
505 King Ave
Columbus Ohio 43201

Job#: G466201-37D0701 (Travis AFB)
Phone: (614) 424-6122
Attn: Eric Drescher

Alpha Analytical Number: BMI020395-01

Client I.D. Number: JFSA-1-FP-1

Compound	Method	Concentration ug/Kg	Detection Limit ug/Kg	Date Analyzed
Benzene	8240	2,200.000	260.000	02/07/95
Toluene	8240	11,000.000	260.000	02/07/95
Total Xylenes	8240	35,000.000	260.000	02/07/95
Ethylbenene	8240	7,900.000	260.000	02/07/95

Orange Compounds	Method	Percentage of Total	Detection Limit (Not Applicable)	Date Analyzed
C9<	GC/FID	48.67	NA	02/06/95
C9	GC/FID	20.85	NA	02/06/95
C10	GC/FID	13.24	NA	02/06/95
C11	GC/FID	6.49	NA	02/06/95
C12	GC/FID	3.90	NA	02/06/95
C13	GC/FID	3.00	NA	02/06/95
C14	GC/FID	2.17	NA	02/06/95
C15	GC/FID	0.94	NA	02/06/95
C16	GC/FID	0.37	NA	02/06/95
C17>	GC/FID	0.8	NA	02/06/95

ND - Not Detected

Approved by: Roger L. Scholl

Roger L. Scholl, Ph.D.
Laboratory Director

Date: 2/16/95

Billing Information:

Name ______

Address ______

City, State, Zip ______

Phone Number ______

Alpha Analytical, Inc
255 Glendale Avenue, Suite 21
Sparks, Nevada 89431
Phone (702) 355-1044
Fax (702) 355-0406

Page # 1 of 1

Client Name: Dattilo

P.O. # [illegible]

Address:

Phone #:

City, State, Zip:

Report Attention:

Sampled by:

Time Sampled	Date Sampled	Type* See Key Below	Lab ID Number	Sample Description	Number of Containers	Analyses Required: BTXE	TPH	TPH							Remarks
	1/21	oil	[illegible]01	JFSA-1-FP-1	1	X	X								[illegible]
	1/21	✓	02	JFSA-1-FP-2	1	X	X								
	1/21	AQ	03	JFSA-1-WS-4	1	X		X							

	Signature	Print Name	Company	Date	Time
Relinquished by					
Received by	[signature]	Linda Lerner	AAI	9/3/95	1100
Relinquished by					
Received by					
Relinquished by					
Received by					

NOTE: Samples are discarded 60 days after results are reported unless other arrangements are made. Hazardous samples will be returned to client or disposed of at client expense.

*Key: AQ - Aqueous SO - Soil WA - Waste OT - OTher

Alpha Analytical, Inc.
[illegible] Suite C
Sparks, Nevada 89431
702) 355-1044
FAX: 702-355-0406
1-800-283-1183

Boise, Idaho
(208) 336-4145

Las Vegas, Nevada
(702) 386-6747

ANALYTICAL REPORT

Battelle
505 King Ave
Columbus Ohio 43201

Job#: 91138/Travis AFB
Phone: (614) 424-6122
Attn: Jeff Kittel

Sampled: 01/21/95 Received: 02/03/95 Analyzed: 02/03/95

Matrix: [ ] Soil [X] Water [ ] Waste

Analysis Requested: TPH - Total Petroleum Hydrocarbons-Purgeable Quantitated As Gasoline
BTXE - Benzene,Toluene,Xylenes,Ethylbenzene

Methodology: TPH - Modified 8015/DHS LUFT Manual/BLS-191
BTXE - Method 624/8240

Results:

Client ID/ Lab ID	Parameter	Concentration	Detection Limit
JFSA-1-WS-4 /BMI020395-03	TPH (Purgeable)	20	5.0 mg/L
	Benzene	1,100	10 ug/L
	Toluene	2,500	10 ug/L
	Total Xylenes	4,400	10 ug/L
	Ethylbenzene	810	10 ug/L

Approved by: Roger L. Scholl Date: 2/16/95
Roger L. Scholl, Ph.D.
Laboratory Director

Battelle
Columbus Laboratories

Form No. ____________

CHAIN OF CUSTODY RECORD

Proj. No. [illegible]

Project Title [illegible]

SAMPLERS: (Signature) [illegible]

SAMPLE TYPE (√)

DATE	TIME	SAMPLE I.D.	[illegible]	[illegible]	[illegible]										Container No.	Number of Containers	Remarks
1/[illegible]/85	1030	[illegible]-1-[illegible] 1	T	X												1	
1/[illegible]/85	0915	[illegible]-1-[illegible]-2	T	X												1	
1/21/85	0910	[illegible]-1-[illegible]	X		X											1	

Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Relinquished by: (Signature)	Date/Time	Received by: (Signature)
[illegible]	1 [illegible] 85				

Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Relinquished by: (Signature)	Date/Time	Received by: (Signature)

Relinquished by: (Signature)	Date/Time	Received for Laboratory by: (Signature)	Date/Time	Remarks

Sierra
Environmental
Monitoring, Inc.

February 13, 1995

TO: **Alpha Analytical**

FROM: Sierra Environmental Monitoring, Inc.

RE: Particle Size Distribution Analysis - SEM 9501-397
BMI012395-01-JFSA-1-MPA-1

As per your request, we have performed particle size analysis on the sample submitted to this laboratory. Test results are as follows:

% Sand	38
% Silt	33
% Clay	29

The sample was passed through a #10 sieve prior to analysis as per procedure. All results are based on oven dry sample weights.

We appreciate this opportunity to provide our laboratory testing services. If you have any questions or require further testing, please feel free to contact us at your convenience.

Sincerely,
SIERRA ENVIRONMENTAL MONITORING, INC.

Stephen Poole
Assistant Manager/ Senior Chemist

hydro7.alp

William F. Pillsbury
President

1135 Financial Blvd.
Reno, NV 89502
Phone (702) 857-2400
FAX (702) 857-2404

John C. Seher
Manager

Sierra
Environmental
Monitoring, Inc.

February 13, 1995

TO: **Alpha Analytical**

FROM: Sierra Environmental Monitoring, Inc.

RE: Particle Size Distribution Analysis - SEM 9501-398
BMI012395-02-JFSA-1-MPC-1

As per your request, we have performed particle size analysis on the sample submitted to this laboratory. Test results are as follows:

% Sand	51
% Silt	24
% Clay	25

The sample was passed through a #10 sieve prior to analysis as per procedure. All results are based on oven dry sample weights.

We appreciate this opportunity to provide our laboratory testing services. If you have any questions or require further testing, please feel free to contact us at your convenience.

Sincerely,
SIERRA ENVIRONMENTAL MONITORING, INC.

Stephen Poole
Assistant Manager/ Senior Chemist

hydro7.alp

William F. Pillsbury
President

1135 Financial Blvd.
Reno, NV 89502
Phone (702) 857-2400
FAX (702) 857-2404

John C. Seher
Manager

Sierra
Environmental
Monitoring, Inc.

February 13, 1995

TO: **Alpha Analytical**

FROM: Sierra Environmental Monitoring, Inc.

RE: Particle Size Distribution Analysis - SEM 9501-399
BMI012395-03-JFSA-1-MPC-2

As per your request, we have performed particle size analysis on the sample submitted to this laboratory. Test results are as follows:

% Sand	54
% Silt	22
% Clay	24

The sample was passed through a #10 sieve prior to analysis as per procedure. All results are based on oven dry sample weights.

We appreciate this opportunity to provide our laboratory testing services. If you have any questions or require further testing, please feel free to contact us at your convenience.

Sincerely,
SIERRA ENVIRONMENTAL MONITORING, INC.

Stephen Poole
Assistant Manager/ Senior Chemist

hydro7.alp

1135 Financial Blvd.
Reno, NV 89502
Phone (702) 857-2400
FAX (702) 857-2404

William F. Pillsbury
President

John C. Seher
Manager

Sierra
Environmental
Monitoring, Inc.

February 13, 1995

TO: **Alpha Analytical**

FROM: Sierra Environmental Monitoring, Inc.

RE: Particle Size Distribution Analysis - SEM 9501-400
BMI012395-04-JFSA-1-MPC-1

As per your request, we have performed particle size analysis on the sample submitted to this laboratory. Test results are as follows:

% Sand	54
% Silt	23
% Clay	23

The sample was passed through a #10 sieve prior to analysis as per procedure. All results are based on oven dry sample weights.

We appreciate this opportunity to provide our laboratory testing services. If you have any questions or require further testing, please feel free to contact us at your convenience.

Sincerely,
SIERRA ENVIRONMENTAL MONITORING, INC.

Stephen Poole
Assistant Manager/ Senior Chemist

hydro7.alp

1135 Financial Blvd.
Reno, NV 89502
Phone (702) 857-2400
FAX (702) 857-2404

William F. Pillsbury
President

John C. Seher
Manager

Laboratory Analysis Report

Sierra Environmental Monitoring, Inc.

ALPHA ANALYTICAL
255 GLENDALE AVENUE, SUITE 21
SPARKS NV 89431

Date : 2/13/95
Client : ALP-855
Taken by: JEFF KITTEL
Report : 12206
PO# :

Sample	Collected Date	Time	ALKALINITY MG/L CACO3	PH S.U.	MOISTURE CONTENT %	NITRATE-N MG/L	KJELDAHL-N MG/L	PHOSPHORUS -TOTAL MG/L
BMI012395-01 - JFSA-1-MPA-1	1/11/95	:	32C 64B	9.56	15.2	3.6 ug/g	3.3 mg/g	0.94ug/g
BMI012395-02 - JFSA-1-MPC-1	1/11/95	:	32C 68B	9.53	14.5	2.8 ug/g	4.7 mg/g	1.48ug/g
BMI012395-03 - JFSA-1-MPC-2	1/11/95	:	20B	7.75	14.5	2.0 ug/g	4.0 mg/g	5.61ug/g
BMI012395-04 - JFSA-1-MPC-3	1/11/95	:	13B	7.40	12.2	2.2 ug/g	5.3 mg/g	6.17ug/g

Sample	Collected Date	Time	TOTAL NITROGEN MG/L	IRON, TOTAL MG/L	DIGESTION-TOTAL METALS	PARTICLE SIZE CLASSIF. HYDROMETER	DENSITY G/CM3	POROSITY %
BMI012395-01 - JFSA-1-MPA-1	1/11/95	:	3.3 mg/g	36 mg/g	YES	YES	1.50	43.4
BMI012395-02 - JFSA-1-MPC-1	1/11/95	:	4.7 mg/g	30 mg/g	YES	YES	1.56	41.1
BMI012395-03 - JFSA-1-MPC-2	1/11/95	:	4.0 mg/g	29 mg/g	YES	YES	1.32	50.2
BMI012395-04 - JFSA-1-MPC-3	1/11/95	:	5.3 mg/g	31 mg/g	YES	YES	1.61	39.2

Approved By: _____

1135 Financial Blvd.
Reno, NV 89502
Phone (702) 857-2400
FAX (702) 857-2404

William F. Pillsbury
President

John C. Seher
Manager

Battelle

Columbus Laboratories

CHAIN OF CUSTODY RECORD

Form No. ______

Proj. No. G-4-2231-30070

Project Title TRAVIS AFB BIOSCREEN.

SAMPLERS: (Signature) [signature]

DATE	TIME	SAMPLE I.D.	TOTAL P	TOTAL N	ALKALINITY	PH	TOTAL Fe	GRAIN-SIZE DIST	BULK DENSITY	POROSITY	MOISTURE	BTEX	TPH			Container No.	Number of Containers	Remarks
1/11/95	1130	TT-A-1-MPA-1	X	X	X	X	X	X	X	X	X	X	X				1	
1/11/95	1530	TT-A-1-MPC-1	X	X	X	X	X	X	X	X	X	X	X				1	
1/11/95	1550	TT-A-1-MPC-2	X	X	X	X	X	X	X	X	X	X	X				1	
1/11/95	1555	TT-A-1-MPC-3	X	X	X	X	X	X	X	X	X	X	X				1	
1/18/95	17:30	TT-A-1-WD-1										X	X				1	
1/20/95	10:55	TT-A-1-WS-2										X	X				1	
1/20/95	10:58	TT-A-1-WS-3										X	X				1	
		REPORT RESULTS TO:																
		JIM [illegible]																
		BATTELLE																
		505 KING AVE																
		COLUMBUS, OHIO 43201																

Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Relinquished by: (Signature)	Date/Time	Received by: (Signature)
[signature]					
Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Relinquished by: (Signature)	Date/Time	Received by: (Signature)

Relinquished by: (Signature)	Date/Time	Received for Laboratory by: (Signature)	Date/Time	Remarks
		[signature]	[illegible]	

Page 1 of 1

Billing Information

Name
Address
City, State, Zip
Phone Number

255 Glendale Avenue, Suite 21
Spar[redacted]vada[redacted]
Phone (702) 355-1044
Fax (702) 355-0406

9116201 - 30070 - Page # 1 of 1

Client Name: Battelle
Address:
City, State, Zip:
P.O.#: Travis AFB Bio Slurp
Phone #:
Report Attention: Jeff Kittel
Sampled by:

Time Sampled	Date Sampled	Type* See Key Below	Lab ID Number	Sample Description	Number of Containers	Total P,N availability	pH total Fe	Grain size	Bulk density porosity	moisture	BTXE	TPH	Remarks
	1/11	SO	BMI012395-01	JFSA-1-MPA-1	1	X	X	X	X	X	X	X	Co.
	↓	✓	02	JFSA-1-MPC-1	1	X	X	X	X	X	X	X	
	↓	✓	03	JFSA-1-MPC-2	1	X	X	X	X	X	X	X	
	↓	✓	04	JFSA-1-MPC-3	1	X	X	X	X	X	X	X	
	1/18	AQ	05	JFSA-1-WS-1	1						X	X	
	1/20	✓	06	JFSA-1-WS-2	1						X	X	
	✓	✓	07	JFSA-1-WS-3	1						X	X	

	Signature	Print Name	Company	Date	Time
Relinquished by					
Received by	Linda Lerner	Linda LERNER	Alpha Analytical	1/23/95	0900
Relinquished by					
Received by					
Relinquished by					
Received by					

NOTE: Samples are discarded 60 days after results are reported unless other arrangements are made. Hazardous samples will be returned to client or disposed of at client expense.

*Key: AQ - Aqueous SO - Soil WA - Waste OT - OTher

Battelle
Columbus Laboratories

CHAIN OF CUSTODY RECORD

Form No. ____________

Proj. No. 446E201-3100701

Project Title TRAVIS AFB BIOSLURPER

SAMPLERS: (Signature) [illegible]

DATE	TIME	SAMPLE I.D.	BTEX	BOILING PT. ANAL.	TPH AS J…	Container No.	Number of Containers	Remarks
1/14/55	1630	JTSA-1-FP-1	+	X			1	[illegible]
1/21/55	0915	JTSA-1-FP-2	+	X			1	
1/21/55	0910	JTSA-1-WS-4	X		X		1	

Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Relinquished by: (Signature)	Date/Time	Received by: (Signature)
[illegible]	1 [illegible]				

Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Relinquished by: (Signature)	Date/Time	Received by: (Signature)

Relinquished by: (Signature)	Date/Time	Received for Laboratory by: (Signature)	Date/Time	Remarks
		[illegible]	[illegible]	

Page ___ of ___

Alpha Analytical, Inc.
255 Glendale Avenue, Suite 21
Sparks, Nevada 89431
(702) 355-1044
FAX: 702-355-0406
1-800-283-1183

Boise, Idaho
(208) 336-4145

2310 W. Charleston, Suite G67
Las Vegas, Nevada 89102
(702) 386-6747

ALPHA ANALYTICAL FAX COVER SHEET

DATE: _____

TIME: _____

FROM: Randy

TO: Matt

NUMBER OF PAGES TO FOLLOW: _____

COMMENTS: _____

Alpha Analytical, Inc.
255 Glendale Avenue, Suite 21
Sparks, Nevada 89431
(702) 355-1044
FAX: 702-355-0406
1-800-283-1183

Boise, Idaho
(208) 336-4145

Las Vegas, Nevada
(702) 386-6747

ANALYTICAL REPORT

Battelle
505 King Ave
Columbus Ohio 43201

Job#: 9462201/Travis AFB
Phone: (614) 424-6122
Attn: Jeff Kittel

Sampled: 01/11/95 Received: 01/23/95 Analyzed: 01/23-24/95

Matrix: [X] Soil [ ] Water [ ] Waste

Analysis Requested: TPH - Total Petroleum Hydrocarbons-Purgeable Quantitated As Gasoline
BTXE - Benzene, Toluene, Xylenes, Ethylbenzene

Methodology: TPH - Modified 8015/DHS LUFT Manual/BLS-191
BTXE - Method 624/8240

Results:

Client ID/ Lab ID	Parameter	Concentration	Detection Limit
JFSA-1-MPA-1 /BMI012395-01	TPH (Purgeable)	12,000	1,000 mg/Kg
	Benzene	63,000	2,000 ug/Kg
	Toluene	220,000	2,000 ug/Kg
	Total Xylenes	370,000	2,000 ug/Kg
	Ethylbenzene	80,000	2,000 ug/Kg
JFSA-1-MPC-1 /BMI012395-02	TPH (Purgeable)	4,200	1,000 mg/Kg
	Benzene	22,000	2,000 ug/Kg
	Toluene	84,000	2,000 ug/Kg
	Total Xylenes	150,000	2,000 ug/Kg
	Ethylbenzene	33,000	2,000 ug/Kg
JFSA-1-MPC-2 /BMI012395-03	TPH (Purgeable)	1,500	1,000 mg/Kg
	Benzene	8,100	2,000 ug/Kg
	Toluene	29,000	2,000 ug/Kg
	Total Xylenes	55,000	2,000 ug/Kg
	Ethylbenzene	12,000	2,000 ug/Kg
JFSA-1-MPC-3 /BMI012395-04	TPH (Purgeable)	2,100	1,000 mg/Kg
	Benzene	9,500	2,000 ug/Kg
	Toluene	38,000	2,000 ug/Kg
	Total Xylenes	80,000	2,000 ug/Kg
	Ethylbenzene	18,000	2,000 ug/Kg

Approved by: Roger L. Scholl Date: 2/2/95
Roger L. Scholl, Ph.D.
Laboratory Director

Alpha Analytical, Inc.
255 Glendale Avenue, Suite 21
Sparks, Nevada 89431
(702) 355-1044
FAX: 702-355-0406
1-800-283-1183

Boise, Idaho
(208) 336-4145

Las Vegas, Nevada
(702) 386-6747

ANALYTICAL REPORT

Battelle
505 King Ave
Columbus Ohio 43201

Job#: 9462201/Travis AFB
Phone: (614) 424-6122
Attn: Jeff Kittel

Sampled: 01/18-20/95 Received: 01/23/95 Analyzed: 01/26/95

Matrix: [ ] Soil [X] Water [ ] Waste

Analysis Requested: TPH - Total Petroleum Hydrocarbons-Purgeable Quantitated As Gasoline
BTXE - Benzene,Toluene,Xylenes,Ethylbenzene

Methodology: TPH - Modified 8015/DHS LUFT Manual/BLS-191
BTXE - Method 624/8240

Results:

Client ID/ Lab ID	Parameter	Concentration	Detection Limit
JFSA-1-WS-1 /BMI012395-05	TPH (Purgeable)	11	5.0 mg/L
	Benzene	910	10 ug/L
	Toluene	1,800	10 ug/L
	Total Xylenes	2,800	10 ug/L
	Ethylbenzene	510	10 ug/L
JFSA-1-WS-2 /BMI012395-06	TPH (Purgeable)	16	5.0 mg/L
	Benzene	1,100	10 ug/L
	Toluene	2,500	10 ug/L
	Total Xylenes	4,300	10 ug/L
	Ethylbenzene	780	10 ug/L
JFSA-1-WS-3 /BMI012395-07	TPH (Purgeable)	20	5.0 mg/L
	Benzene	1,000	10 ug/L
	Toluene	2,100	10 ug/L
	Total Xylenes	4,000	10 ug/L
	Ethylbenzene	710	10 ug/L

Approved by: Roger L. Scholl Date: 2/2/95
Roger L. Scholl, Ph.D.
Laboratory Director

AIR TOXICS LTD.

AN ENVIRONMENTAL ANALYTICAL LABORATORY

WORK ORDER #: 9501182

Work Order Summary

CLIENT: Mr. Eric Dreschler
Battelle
505 King Avenue
Columbus, OH 43201

BILL TO: Same

PHONE: 614-424-4996
FAX: 614-424-3667
DATE RECEIVED: 1/30/95
DATE COMPLETED: 2/3/95

INVOICE # 5974
P.O. # 91221
PROJECT # 30B0201 BIOSLURPER
AMOUNT$: $541.34

FRACTION #	NAME	TEST	RECEIPT VAC./PRES.	PRICE
01A	JFSA-1-OGS-1	TO-3	0.8 psi	$120.00
02A	JFSA-1-OGS-2	TO-3	0.4 psi	$120.00
03A	JFSA-1-OGS-3	TO-3	0.4 psi	$120.00
04A	JFSA-1-OGS-4	TO-3	0.4 psi	$120.00
04B	JFSA-1-OGS-4 Duplicate	TO-3	0.4 psi	NC
05A	Method Spike	TO-3	NA	NC
06A	Lab Blank	TO-3	NA	NC

Misc. Charges	1 Liter SUMMA Canister Preparation (4) @ $10.00 each.	$40.00
	Shipping (1/6/95)	$21.34

CERTIFIED BY: Linda J. Fremmar
Laboratory Director

DATE: 2/3/95

180 BLUE RAVINE ROAD, SUITE B • FOLSOM, CA 95630
(916) 985-1000 • FAX (916) 985-1020

AIR TOXICS LTD.

SAMPLE NAME: JFSA-1-OGS-1
ID#: 9501182-01A

EPA METHOD TO-3
(Aromatic Volatile Organics in Air)

GC/PID

File Name: 60I3I23 Date of Collection: I/I8/95
Dil. Factor: I600 Date of Analysis: I/3I/95

Compound	Det. Limit (ppmv)	Det. Limit (uG/L)	Amount (ppmv)	Amount (uG/L)
Benzene	1.6	5.2	93	300
Toluene	1.6	6.1	200	760
Ethyl Benzene	1.6	7.1	64	280
Total Xylenes	1.6	7.1	260	1100

TOTAL PETROLEUM HYDROCARBONS
GC/FID
(Quantitated as Jet Fuel)

File Name: 60I3I23 Date of Collection: I/I8/95
Dil. Factor: I600 Date of Analysis: I/3I/95

Compound	Det. Limit (ppmv)	Det. Limit (uG/L)	Amount (ppmv)	Amount (uG/L)
TPH* (C5+ Hydrocarbons)	16	100	10000	65000
C2 - C4** Hydrocarbons	16	29	Not Detected	Not Detected

*TPH referenced to Jet Fuel (MW=156)
**C2 - C4 Hydrocarbons referenced to Propane (MW=44)

Container Type: 1 Liter SUMMA Canister

AIR TOXICS LTD.

SAMPLE NAME: JFSA-1-OGS-2
ID#: 9501182-02A

EPA METHOD TO-3
(Aromatic Volatile Organics in Air)

GC/PID

File Name: 60131124 Date of Collection: 1/18/95
Dil. Factor: 1600 Date of Analysis: 1/31/95

Compound	Det. Limit (ppmv)	Det. Limit (uG/L)	Amount (ppmv)	Amount (uG/L)
Benzene	1.6	5.2	96	310
Toluene	1.6	6.1	190	730
Ethyl Benzene	1.6	7.1	59	260
Total Xylenes	1.6	7.1	230	1000

TOTAL PETROLEUM HYDROCARBONS
GC/FID
(Quantitated as Jet Fuel)

File Name: 60131124 Date of Collection: 1/18/95
Dil. Factor: 1600 Date of Analysis: 1/31/95

Compound	Det. Limit (ppmv)	Det. Limit (uG/L)	Amount (ppmv)	Amount (uG/L)
TPH* (C5+ Hydrocarbons)	16	100	10000	65000
C2 - C4** Hydrocarbons	16	29	Not Detected	Not Detected

*TPH referenced to Jet Fuel (MW=156)
**C2 - C4 Hydrocarbons referenced to Propane (MW=44)

Container Type: 1 Liter SUMMA Canister

AIR TOXICS LTD.

SAMPLE NAME: JFSA-1-OGS-3
ID#: 9501182-03A

EPA METHOD TO-3
(Aromatic Volatile Organics in Air)

GC/PID

File Name: 6013I25 Date of Collection: 1/20/95
Dil. Factor: 1600 Date of Analysis: 1/31/95

Compound	Det. Limit (ppmv)	Det. Limit (uG/L)	Amount (ppmv)	Amount (uG/L)
Benzene	1.6	5.2	79	260
Toluene	1.6	6.1	180	690
Ethyl Benzene	1.6	7.1	56	250
Total Xylenes	1.6	7.1	230	1000

TOTAL PETROLEUM HYDROCARBONS
GC/FID
(Quantitated as Jet Fuel)

File Name: 6013I25 Date of Collection: 1/20/95
Dil. Factor: 1600 Date of Analysis: 1/31/95

Compound	Det. Limit (ppmv)	Det. Limit (uG/L)	Amount (ppmv)	Amount (uG/L)
TPH* (C5+ Hydrocarbons)	16	100	9200	60000
C2 - C4** Hydrocarbons	16	29	Not Detected	Not Detected

*TPH referenced to Jet Fuel (MW=156)
**C2 - C4 Hydrocarbons referenced to Propane (MW=44)

Container Type: 1 Liter SUMMA Canister

AIR TOXICS LTD.

SAMPLE NAME: JFSA-1-OGS-4
ID#: 9501182-04A

EPA METHOD TO-3
(Aromatic Volatile Organics in Air)

GC/PID

File Name: 6013126 Date of Collection: 1/21/95
Dil. Factor: 1600 Date of Analysis: 1/31/95

Compound	Det. Limit (ppmv)	Det. Limit (uG/L)	Amount (ppmv)	Amount (uG/L)
Benzene	1.6	5.2	130	420
Toluene	1.6	6.1	290	1100
Ethyl Benzene	1.6	7.1	79	350
Total Xylenes	1.6	7.1	310	1400

TOTAL PETROLEUM HYDROCARBONS
GC/FID
(Quantitated as Jet Fuel)

File Name: 6013126 Date of Collection: 1/21/95
Dil. Factor: 1600 Date of Analysis: 1/31/95

Compound	Det. Limit (ppmv)	Det. Limit (uG/L)	Amount (ppmv)	Amount (uG/L)
TPH* (C5+ Hydrocarbons)	16	100	14000	91000
C2 - C4** Hydrocarbons	16	29	84	150

*TPH referenced to Jet Fuel (MW=156)
**C2 - C4 Hydrocarbons referenced to Propane (MW=44)

Container Type: 1 Liter SUMMA Canister

AIR TOXICS LTD.

SAMPLE NAME: JFSA-1-OGS-4 Duplicate
ID#: 9501182-04B

EPA METHOD TO-3
(Aromatic Volatile Organics in Air)

GC/PID

File Name: 60131127 Date of Collection: 1/21/95
Dil. Factor: 1600 Date of Analysis: 1/31/95

Compound	Det. Limit (ppmv)	Det. Limit (uG/L)	Amount (ppmv)	Amount (uG/L)
Benzene	1.6	5.2	120	390
Toluene	1.6	6.1	280	1100
Ethyl Benzene	1.6	7.1	76	340
Total Xylenes	1.6	7.1	300	1300

TOTAL PETROLEUM HYDROCARBONS
GC/FID
(Quantitated as Jet Fuel)

File Name: 60131127 Date of Collection: 1/21/95
Dil. Factor: 1600 Date of Analysis: 1/31/95

Compound	Det. Limit (ppmv)	Det. Limit (uG/L)	Amount (ppmv)	Amount (uG/L)
TPH* (C5+ Hydrocarbons)	16	100	13000	84000
C2 - C4** Hydrocarbons	16	29	82	150

*TPH referenced to Jet Fuel (MW=156)
**C2 - C4 Hydrocarbons referenced to Propane (MW=44)

Container Type: 1 Liter SUMMA Canister

AIR TOXICS LTD.

SAMPLE NAME: Method Spike
ID#: 9501182-05A

EPA METHOD TO-3
(Aromatic Volatile Organics in Air)

GC/PID

File Name: 60131116 Date of Collection: NA
Dil. Factor: 1.0 Date of Analysis: 1/31/95

Compound	Det. Limit (ppmv)	Det. Limit (uG/L)	% Recovery
Benzene	0.001	0.003	80
Toluene	0.001	0.004	85
Ethyl Benzene	0.001	0.004	79
Total Xylenes	0.001	0.004	82

TOTAL PETROLEUM HYDROCARBONS
GC/FID
(Quantitated as Jet Fuel)

File Name: 60131117 Date of Collection: NA
Dil. Factor: 1.0 Date of Analysis: 1/31/95

Compound	Det. Limit (ppmv)	Det. Limit (uG/L)	% Recovery
TPH* (C5+ Hydrocarbons)	0.010	0.065	81
C2 - C4** Hydrocarbons	0.010	0.018	81

*TPH referenced to Jet Fuel (MW=156)
**C2 - C4 Hydrocarbons referenced to Propane (MW=44)

Container Type: NA

AIR TOXICS LTD.

SAMPLE NAME: Lab Blank
ID#: 9501182-06A

EPA METHOD TO-3
(Aromatic Volatile Organics in Air)

GC/PID

File Name: 6013120 Date of Collection: NA
Dil. Factor: 1.0 Date of Analysis: 1/31/95

Compound	Det. Limit (ppmv)	Det. Limit (uG/L)	Amount (ppmv)	Amount (uG/L)
Benzene	0.001	0.003	Not Detected	Not Detected
Toluene	0.001	0.004	Not Detected	Not Detected
Ethyl Benzene	0.001	0.004	Not Detected	Not Detected
Total Xylenes	0.001	0.004	Not Detected	Not Detected

TOTAL PETROLEUM HYDROCARBONS
GC/FID
(Quantitated as Jet Fuel)

File Name: 6013120 Date of Collection: NA
Dil. Factor: 1.0 Date of Analysis: 1/31/95

Compound	Det. Limit (ppmv)	Det. Limit (uG/L)	Amount (ppmv)	Amount (uG/L)
TPH* (C5+ Hydrocarbons)	0.010	0.065	Not Detected	Not Detected
C2 - C4** Hydrocarbons	0.010	0.018	Not Detected	Not Detected

*TPH referenced to Jet Fuel (MW=156)
**C2 - C4 Hydrocarbons referenced to Propane (MW=44)

Container Type: NA

AIR TOXICS LTD.
AN ENVIRONMENTAL ANALYTICAL LABORATORY

180 BLUE RAVINE ROAD, SUITE B
FOLSOM, CA 95630-4719
(916) 985-1000 FAX: (916) 985-1020

No 002578

CHAIN-OF-CUSTODY RECORD

Page 1 of 1

Contact Person: JEFF KITCL
Company: BATTELLE
Address: 505 KING AVE City: COLUMBUS State: OH Zip: 43201
Phone: (614) 424-6122 FAX: 614-424-3667

Project Info:
P.O. #:
Project #:
Project Name: TRAVIS AFB BIOSLURPER

Turn Around Time:
☒ Normal
☐ Rush ____ Specify

Lab I.D.	Field Sample I.D.	Date & Time	Analyses Requested	Canister Pressure / Vacuum Initial	Final	Receipt
01A	JFSA-1-095-1	1/18/95 0800	BTEX, TPH L	30	0	0.7
02A	JFSA-1-095-2	1/18/95 0805	BTEX, TPH	30	0	0.4
03A	JFSA-1-095-3	1/21/95 1050	BTEX, TPH	30	0	0.4
04A/B	JFSA-1-095-4	1/21/95 0800	BTEX, TPH	30	0	0.4

Collected By: Print M. PLACE Signature

Relinquished By: (Signature) Date/Time: M. Place 1/25/95
Received By: (Signature) Date/Time:

Relinquished By: (Signature) Date/Time:
Received By: (Signature) Date/Time:

Relinquished By: (Signature) Date/Time:
Received By: (Signature) Date/Time: 1/30/95 9:20

Notes:

Lab Use Only

Shipper Name	Air Bill #	Opened By:	Date/Time	Temp. (°C)	Condition	Custody Seals Intact?	Work Order #
FedEx	122 9248 064		1/30/95 9:20	Ambient	Good	Yes No (None)	

Form 1293 rev. 05

APPENDIX D

SOIL GAS PERMEABILITY TEST RESULTS

	Travis Air Force Base MPA		
	Vaccum in Inches of Water		
Time	MPA-3	MPA-5.5	MPA-8
0	0.00	0.00	0.00
1	0.00	0.80	0.00
2	0.00	0.10	0.00
5	0.00	0.12	0.01
7	0.01	0.10	0.01
8	0.01	0.10	0.01
9	0.00	0.14	0.01
10	0.02	0.15	0.15
11	0.00	0.17	0.15
12	0.00	0.18	0.16
13	0.00	0.19	0.17
14	0.00	0.21	0.18
15	0.00	0.22	0.18
16	0.00	0.23	0.19
17	0.00	0.25	0.22
20	0.00	0.25	0.24
22	0.00	0.26	0.30
24	0.00	0.29	0.31
26	0.00	0.32	0.31
28	0.00	0.34	0.32
30	0.00	0.34	0.33
35	0.00	0.35	0.34
40	0.00	0.45	0.45
50	0.00	0.50	0.49
55	0.00	0.54	0.50
60	0.00	0.55	0.55
75	nd	0.65	0.55
90	nd	0.70	0.65
105	nd	0.70	0.65
120	nd	0.70	0.65
240	0.55	0.95	0.95
870	0.55	0.55	0.60

	Travis Air Force Base MPC		
	Vacuum in Inches of Water		
Time	MPC-2.5	MPC-5.5	MPC-8
0	0.00	0.00	0.00
1	0.00	0.00	0.00
2	0.00	0.10	0.00
3	0.01	0.05	0.00
6	0.01	0.08	0.00
9	0.03	0.09	0.00
11	0.03	0.10	0.00
19	0.04	0.17	0.02
31	0.04	0.18	0.01
42	0.04	0.25	0.01
62	0.13	0.35	0.12
93	0.15	0.40	0.25
105	0.15	0.40	0.30
120	0.15	0.40	0.30
240	0.16	0.50	0.40
870	0.25	0.80	0.85

Soil Gas Permeability

Site Name: Travis AFB **Date:** 12/27/94

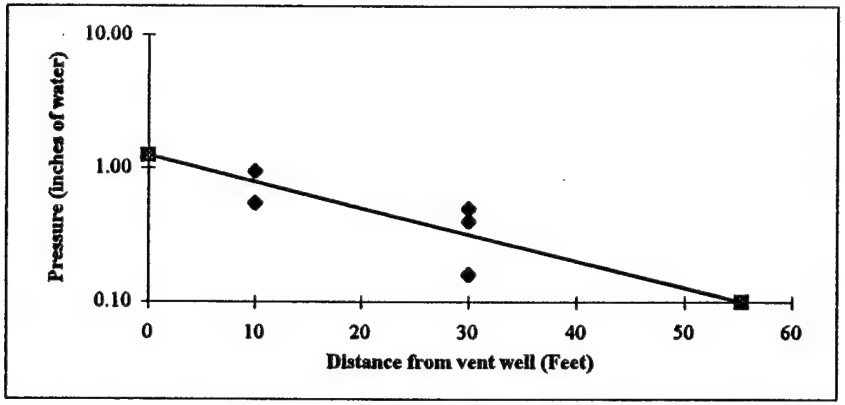
Item	Symbol	Value	Unit
Volumetric Flow Rate from the Vent Well	Q	47.45	cm^3/s
Viscosity of Air (1.8×10^{-4} g/cm-s at 64.4 °F (18° C)	u	1.80E-04	g/cm-s
Ambient pressure (at sea level 1.013×10^6 g/cm-s^2)	P_{atm}	9.46E+05	g/cm-s^2
Absolute Pressure at the Venting Well	P_w	9.64E+05	g/cm-s^2
Radius of Venting Well	R_w	15.24	cm
Depth of Screen	H	222.6	cm
Radius of Influence-Previously determined	R_I	1685.01	cm
Soil Gas Permeability (for Vacuum Well)	k	0.16	darcy
Soil Gas Permeability (for Air Injection Well)	k	0.16	darcy

Radius of Influence

Site Name Travis AFB **Date:** 12/27/94

Time (min.)	Air Flow (cfm)	Vacuum (inches of water)													
		green	blue	red	green	blue	red	blue	black	clear	orange	yellow	blue	green	red
0.00		0.00	0.00	0.00	0.00	0.00	0.00								
9.00		0.05	0.14	0.01	0.03	0.09	0.00								
31.00		0.10	0.34	0.33	0.04	0.18	0.01								
60.00		0.15	0.55	0.55	0.13	0.35	0.22								
105.00		0.25	0.70	0.70	0.15	0.40	0.30								
120.00		0.30	0.70	0.65	0.15	0.40	0.30								
240.00		0.55	0.95	0.95	0.16	0.50	0.40								
Distance (ft)		10	10	10	30	30	30								

R_I: 55.28 ft



APPENDIX E

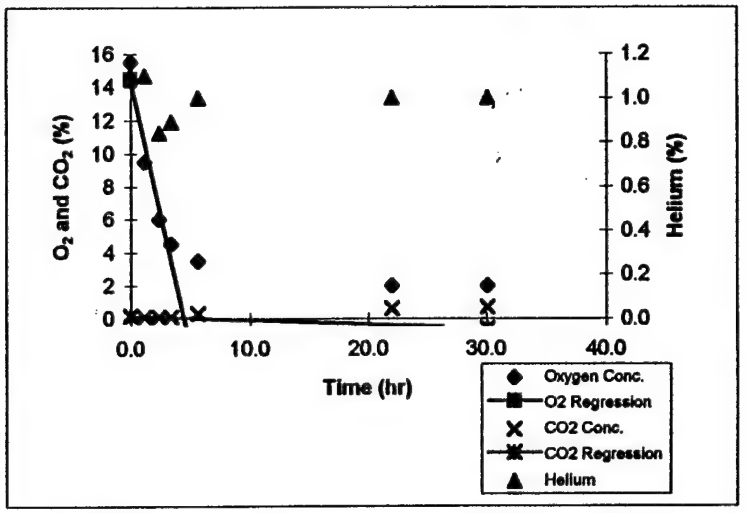
IN SITU RESPIRATION TEST RESULTS

Utilization Rates (1)

Date: 1/23/95 **Site Name:** Travis AFB

Monitoring Point: MPA **Depth of M.P. (ft):** 5.5

Date/Time (mm/dd/yr hr:min)	Time (hr)	Oxygen (%)	Carbon Dioxide (%)	Helium (%)
1/23/95 11:05	0.0	15.50	0.20	1.10
1/23/95 12:15	1.2	9.50	0.10	1.10
1/23/95 13:30	2.4	6.00	0.10	0.84
1/23/95 14:30	3.4	4.50	0.10	0.89
1/23/95 16:45	5.7	3.50	0.30	1.00
1/24/95 9:05	22.0	2.00	0.60	1.00
1/24/95 17:10	30.1	2.00	0.70	1.00



O_2 Utilization Rate

Ko	0.053 %/min
	3.195 %/hr
	76.679 %/day

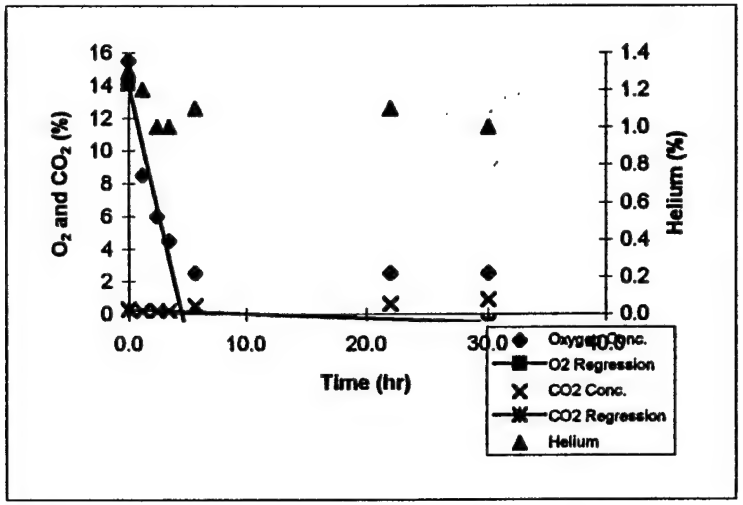
Regression Lines	O_2	CO_2
Slope	-3.1950	-0.0264
Intercept	14.4662	0.1712
Determination Coef.	0.9434	0.6164
No. of Data Points.	4	4

Utilization Rates (2)

Date: 1/23/95 **Site Name:** Travis AFB

Monitoring Point: MPB **Depth of M.P. (ft):** 8

Date/Time (mm/dd/yr hr:min)	Time (hr)	Oxygen (%)	Carbon Dioxide (%)	Helium (%)
1/23/95 11:05	0.0	15.50	0.30	1.30
1/23/95 12:15	1.2	8.50	0.20	1.20
1/23/95 13:30	2.4	6.00	0.20	1.00
1/23/95 14:30	3.4	4.50	0.20	1.00
1/23/95 16:45	5.7	2.50	0.50	1.10
1/24/95 9:05	22.0	2.50	0.60	1.10
1/24/95 17:10	30.1	2.50	0.90	1.00



O_2 Utilization Rate

Ko	0.052 %/min
	3.107 %/hr
	74.566 %/day

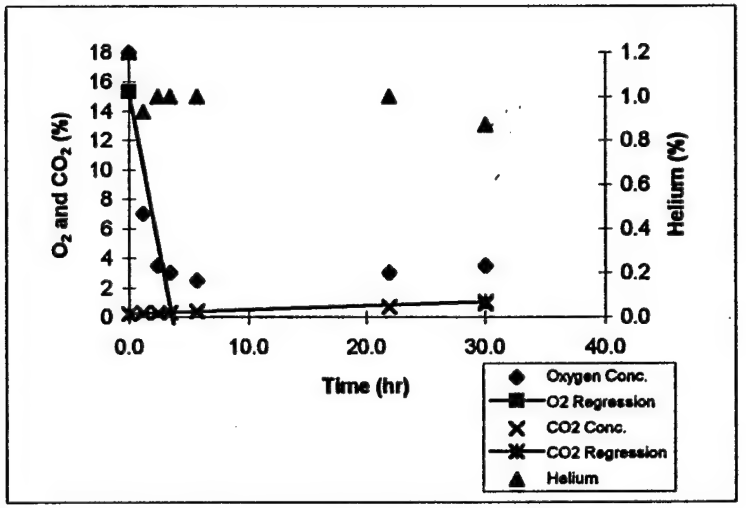
Regression Lines	O_2	CO_2
Slope	-3.1069	-0.0264
Intercept	14.0621	0.2712
Determination Coef.	0.8983	0.6164
No. of Data Points.	4	4

Utilization Rates (3)

Date: 1/23/95 **Site Name:** Travis AFB

Monitoring Point: MPC **Depth of M.P. (ft):** 5.5

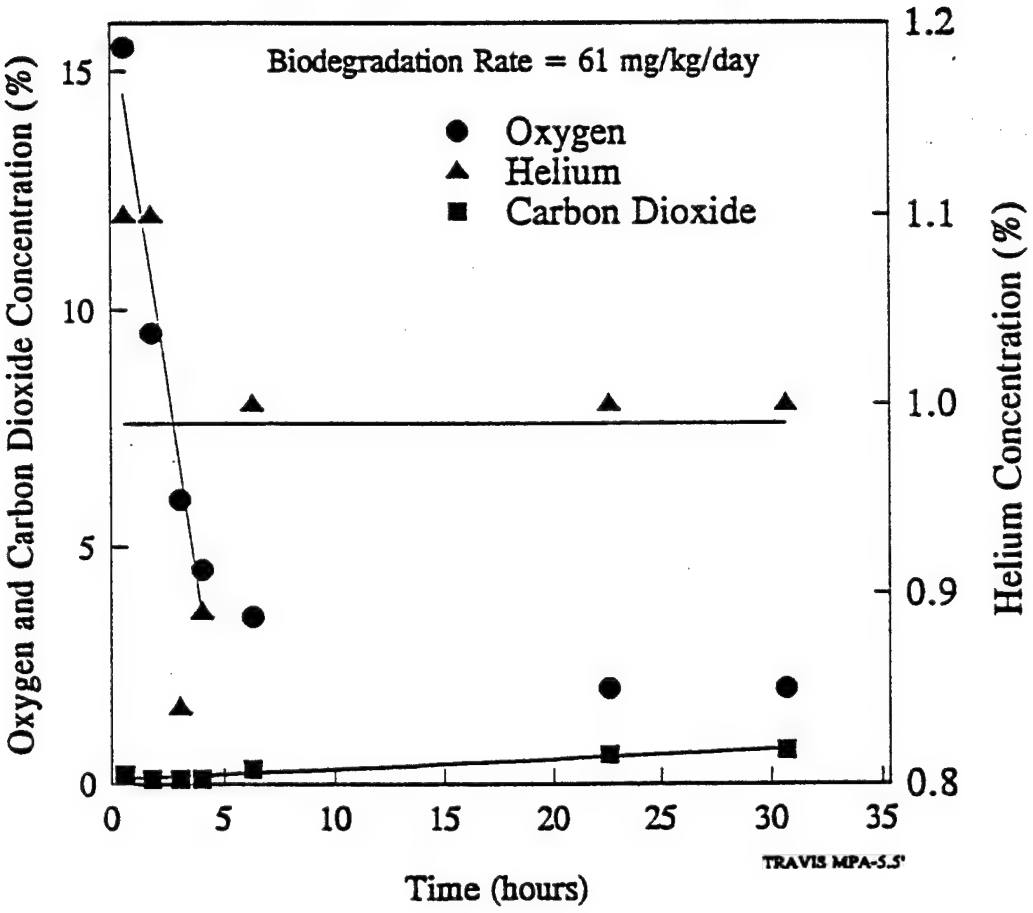
Date/Time (mm/dd/yr hr:min)	Time (hr)	Oxygen (%)	Carbon Dioxide (%)	Helium (%)
1/23/95 11:05	0.0	18.00	0.20	1.20
1/23/95 12:15	1.2	7.00	0.30	0.93
1/23/95 13:30	2.4	3.50	0.30	1.00
1/23/95 14:30	3.4	3.00	0.30	1.00
1/23/95 16:45	5.7	2.50	0.40	1.00
1/24/95 9:05	22.0	3.00	0.70	1.00
1/24/95 17:10	30.1	3.50	0.90	0.87

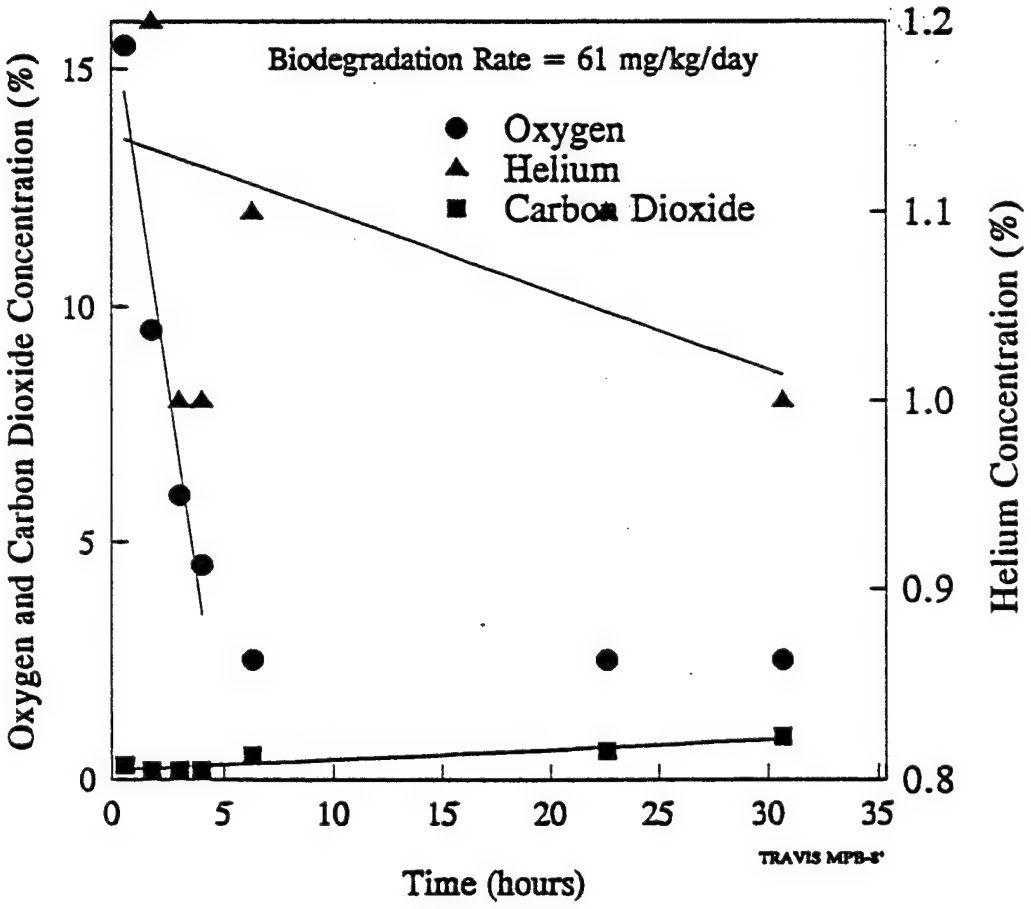


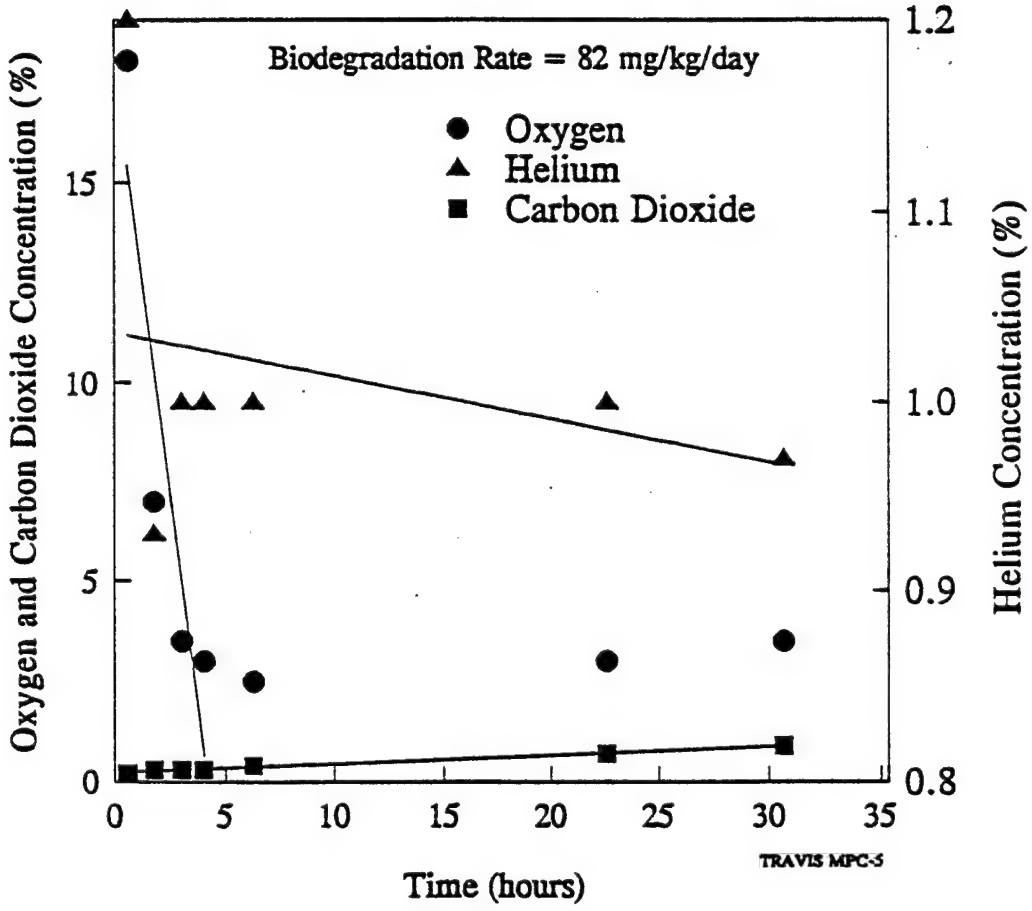
O_2 Utilization Rate

Ko	0.071	%/min
	4.264	%/hr
	102.340	%/day

Regression Lines	O_2	CO_2
Slope	-4.2642	0.0264
Intercept	15.3373	0.2288
Determination Coef.	0.8240	0.6164
No. of Data Points.	4	4

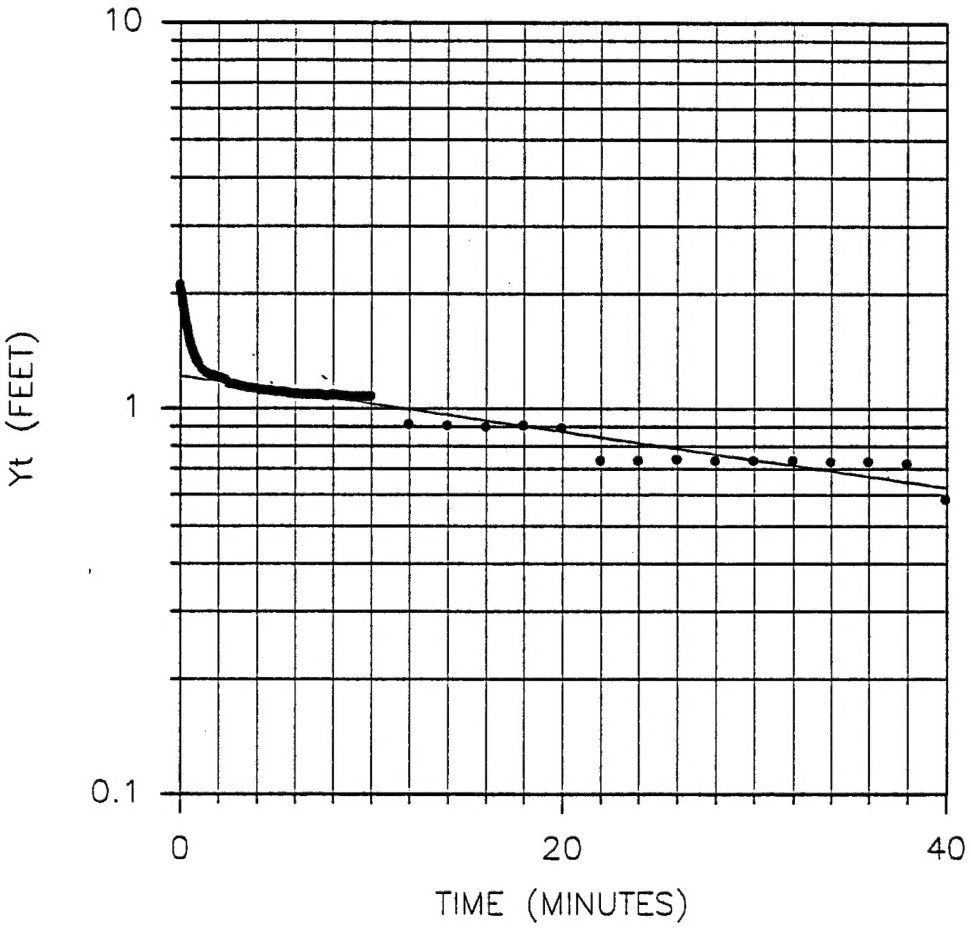

Biodegradation Rate = 61 mg/kg/day
Oxygen
Helium
Carbon Dioxide
Oxygen and Carbon Dioxide Concentration (%)
Helium Concentration (%)
Time (hours)
0
5
10
15
20
25
30
35
0.8
0.9
1.0
1.1
1.2
TRAVIS MPA-5.5'


Biodegradation Rate = 61 mg/kg/day
Oxygen
Helium
Carbon Dioxide
Oxygen and Carbon Dioxide Concentration (%)
Helium Concentration (%)
Time (hours)
0
5
10
15
20
25
30
35
0.8
0.9
1.0
1.1
1.2
TRAVIS MPB-8

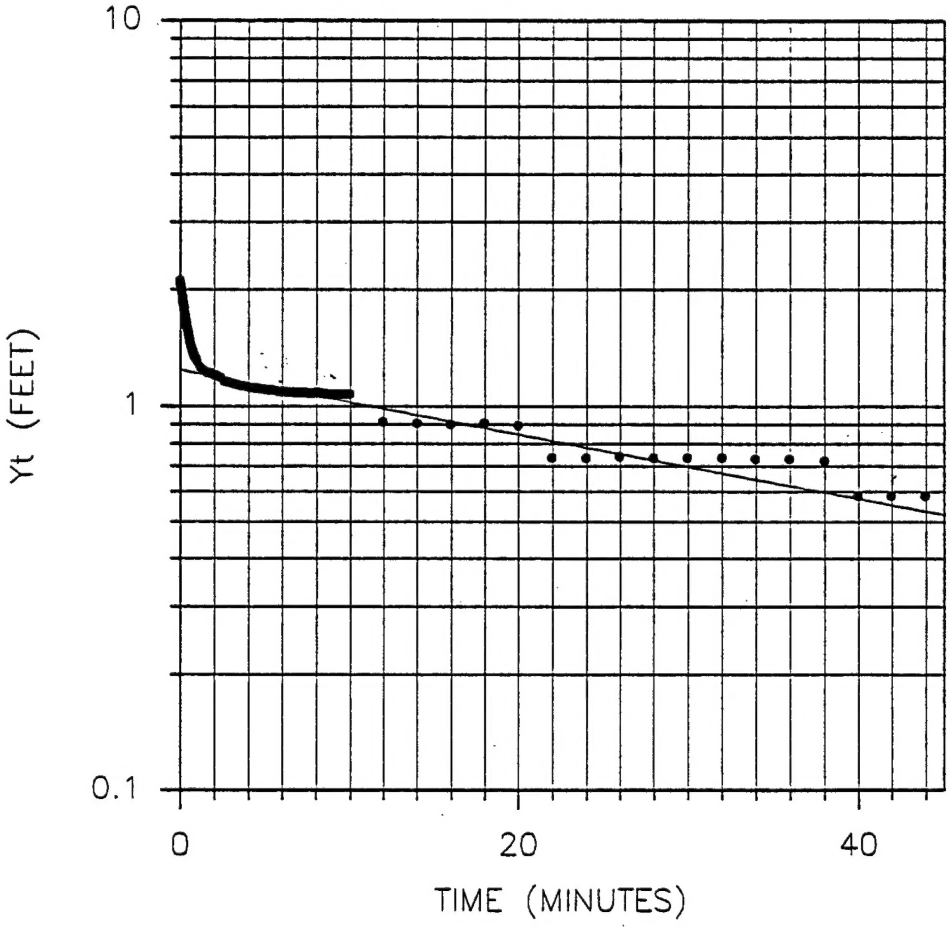

Biodegradation Rate = 82 mg/kg/day
Oxygen
Helium
Carbon Dioxide
Oxygen and Carbon Dioxide Concentration (%)
Helium Concentration (%)
Time (hours)
0
5
10
15
20
25
30
35
0.8
0.9
1.0
1.1
1.2
TRAVIS MPC-5

APPENDIX F

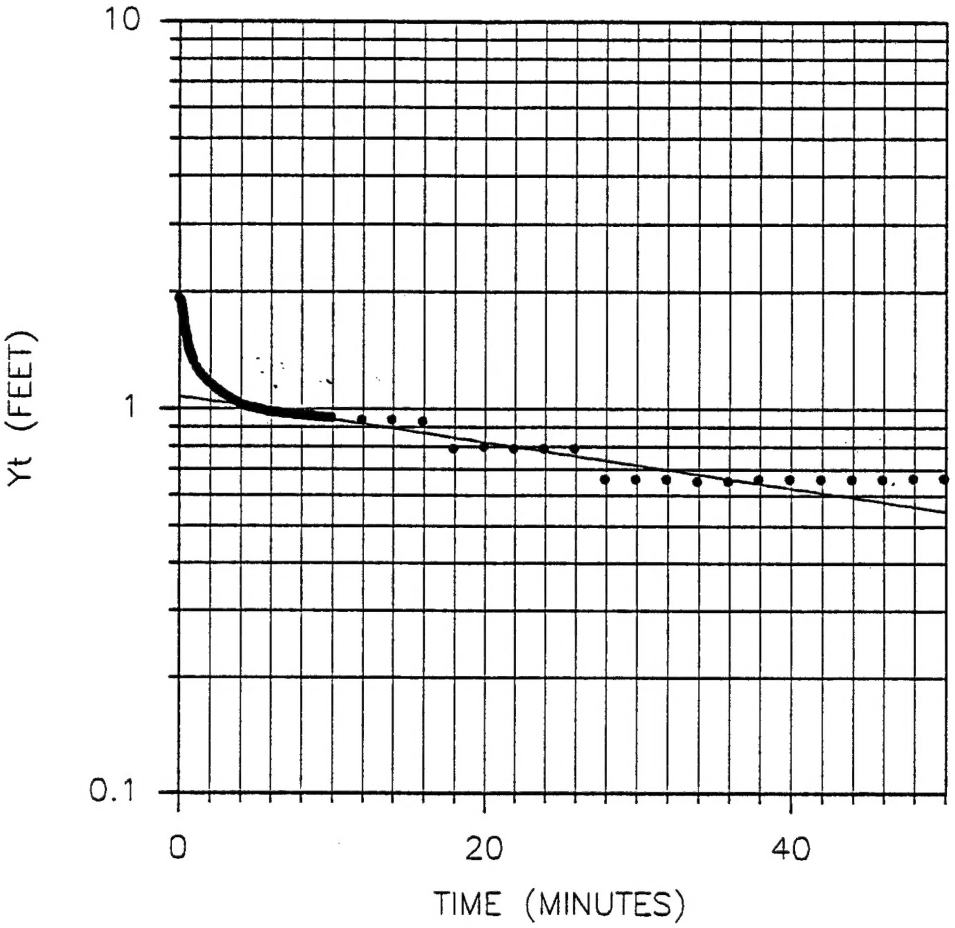
SLUG TESTING RESULTS



Bouwer and Rice Slug Test Analysis						
Well 5303 - Replicate #1						
D =	37	ft				
L =	15	ft				
H =	12.39	ft				
rw =	1.25	ft				
rc =	0.5	ft				
L/rw =	12.00			ln Re/rw =	1.05	
A =	2			Re =	3.56	
B =	1.25					
t =	18	min		K =	0.20	ft/day
Yt =	0.9	ft				
Yo =	1.2	ft				



Bouwer and Rice Slug Test Analysis						
Well 5303 - Replicate #2						
D =	37	ft				
L =	15	ft				
H =	12.39	ft				
rw =	1.25	ft				
rc =	0.5	ft				
L/rw =	12.00			ln Re/rw =	1.05	
A =	2			Re =	3.56	
B =	1.25					
t =	30	min		K =	0.26	ft/day
Yt =	0.7	ft				
Yo =	1.3	ft				



Bouwer and Rice Slug Test Analysis						
Well 5303 - Replicate #~~2~~ 3						
D =	37	ft				
L =	15	ft				
H =	12.39	ft				
rw =	1.25	ft				
rc =	0.5	ft				
L/rw =	12.00			ln Re/rw =	1.05	
A =	2			Re =	3.56	
B =	1.25					
t =	22	min		K =	0.18	ft/day
Yt =	0.8	ft				
Yo =	1.1	ft				